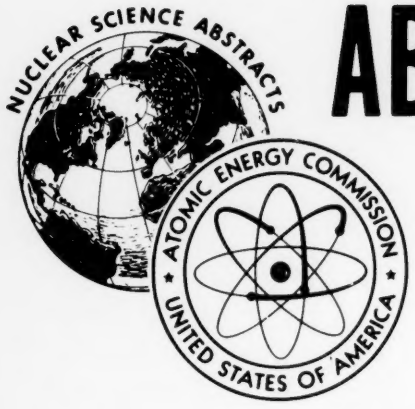
NUCLEAR SCIENCE ABSTRACTS



Volume 27 Number 5

Abstracts 9265-11643

March 15, 1973

UNITED STATES ATOMIC ENERGY COMMISSION

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Volume 27, Number 5, March 15, 1973

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Nuclear Science Abstracts provides the only comprehensive abstracting and indexing coverage of the international nuclear science literature. It covers scientific and technical reports of the U. S. Atomic Energy Commission and its contractors, other U. S. Government agencies, other governments, universities, and industrial and research organizations. In addition, books, conference proceedings, individual conference papers, patents, and journal literature on a worldwide basis are abstracted and indexed. Each issue of *Nuclear Science Abstracts* includes four indexes: subject, personal author, corporate author, and report number.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)
TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Catta-augus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation ccunting, 25:40 (IDO-12073, pp 28-36)

Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

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Use of funds for printing this publication approved by the Director of the Office of Management and Budget, June 19, 1972.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

9265 (AEC-tr-7102/9-10) NUKLEONIKA. Translation of Nukleonika; 15: No. 9-10, 585-704(1970). 107p. (TT-70-55010/9-10). Dep. NTIS.

Analytical Chemistry

Refer also to abstracts 9676, 9682, 9770, 9918, and 9939.

9266 (EUR-4855) ANNUAL PROGRESS REPORT, 1971. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Aug 1972. 82p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 125.-.

ANALYTICAL CHEMISTRY—research at Central Bureau for Nuclear Measurements, Belgium, 1972

NEUTRON CROSS SECTIONS—research at Central Bureau for Nuclear Measurements, Belgium, 1972

NUCLEAR PHYSICS—research at Central Bureau for Nuclear Measurements, Belgium, 1972 (TSS)

Activation and Nuclear Reaction Procedures

Refer also to abstract 9759.

9267 (CONF-720701-(Absts.), pp 110-11) DELAYED FISSION NEUTRON SPECTROMETRY AND ITS APPLICATION TO NUCLEAR MATERIALS ASSAY. Shalev, S. (Technion, Haifa, Israel). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9268 (CONF-721010-8) DETERMINATION OF TRACE METALS AND FLUORIDE IN MINERALOGICAL AND BIOLOGICAL SAMPLES FROM THE MARINE ENVIRONMENT. Bressan, D. J.; Carr, R. A.; Hannan, P. J.; Wilkniss, P. E. (Naval Research Lab., Washington, D. C.). 1972. 10p.

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Trace metals and fluoride were determined by activation analysis in atmospheric dust collected over different world oceans. Neutron activation was used for metals analysis, and photon activation was employed to assess fluoride. The importance of the results obtained for Hg and F in environmental considerations is discussed in some detail. Mercury uptake studies were performed in the laboratory with the marine algae, phaeodactylum tricornutum. In preliminary radiotracer experiments (^{197}Hg), different experimental parameters were evaluated. Final results obtained for mercury concentrations in algae are compared with atomic absorption analysis findings. (auth)

9269 (CONF-721010-10) RESULTS FROM MULTI-TRACE-ELEMENT NEUTRON ACTIVATION. ANALYSES OF MARINE BIOLOGICAL SPECIMENS. Guinn, V. P.; Kishore, Raj (California Univ., Irvine. Dept. of Chemistry). 1972. 5p.

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A large number of marine biological samples, ranging from kelp on up to tuna, swordfish, and marine mammals, were analyzed for trace levels of mercury, selenium, and zinc by means of instrumental thermal neutron activation analysis, employing Ge(Li) gamma-ray spectrometry. Under the conditions used, levels as low as 0.01 ppM Hg, 0.02 ppM Se, and 0.2 ppM Zn are detectable instrumentally. Many interesting results have been obtained, and are described. This study is being extended to other trace elements, utilizing post-irradiation radiochemical separations. (France)

9270 (CONF-721010-11) ANALYSIS OF MAN. Lenihan, J. M. A. (Glasgow Univ. (Scotland)). 1972. 7p. Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

Neutron activation analysis in vivo has been applied to the study of whole-body and partial-body composition (Na,Ca). The technique involves many experimental and ethical difficulties and has so far had limited success but is probably capable of useful development. For several elements (I in thyroid and blood serum), an alternative approach (based on tracer studies and activation analysis in vitro) deserves further attention. (France)

9271 (LYCEN-7249) CHEMICAL SEPARATION OF ^{18}F. APPLICATION TO THE Al MATRIX. Benmalek, M.; Chermette, H.; Martelet, C.; Sandino, D.; Tousset, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 7p. (In French). (CONF-721010-5). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A solvent extraction method for rapidly separating ^{18}F from an Al matrix is presented. The conditions necessary to form the complex and to accomplish the solvent extraction using triphenylantimony dichloride are discussed. In this way pure ^{18}F is obtained. (France)

9272 (LYCEN-7251) OBSERVATIONS OF SECONDARY REACTIONS AND THE SEPARATION OF ^{18}F. Giroux, J.; Thomas, J. P. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 13p. (In French). (CONF-721010-7). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

The determination of O in Si and Ge by activation with α particle and ^{3}He beams was studied. The nondestructive analysis currently used for Si is described. A new method of separating ^{18}F from impurities produced by irradiating the Ge matrix is proposed. (France)

9273 (LYCEN-7254) ANALYSIS OF THIN FILMS OF CHALCOGENIDE GLASSES BY ELASTIC SCATTERING OF PROTONS AND ANALYSIS OF PROMPT GAMMA RAYS. Cohen, M.; Porte, L.; Thomas, J. P.; Tousset, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 12p. (In French). (CONF-721010-6). Dep. NTIS (U. S. Sales Only).

From International conference on modern trends in activation analysis; Saclay, France (2 Oct 1972).

A method for studying the stoichiometric composition of thin films (10 to 500 $\mu g/cm^2$) of chalcogenide glasses was developed. Studies of the nuclear reactions induced when Ge, As, Te, and S are bombarded with low energy protons (<4 MeV) led to the adopting of elastic scattering and the detection of prompt gamma rays for the simultaneous determination. The accuracy and the sensitivity of the method are discussed from the results obtained: the homogeneity of the targets was investigated by measurements of the fine resonance of the (p,p'γ) reaction with sulfur. (France)

9274 DUAL-RANGE ALPHA COUNTER (1 Apr 1972) (Engineering Materials). (Dow Chemical Co., Denver, Colo. Rocky Flats Div.). (CAPE-2280).

8 drawings.

A mobile, transistorized two-range alpha particle counter is described. The unit has the capability of detecting alpha-particle radiation with two air-proportional detectors. Integrated circuits and discrete components used in the unit provide pulse amplification, normalization, and current drive to a rate meter and aural readout. The system provides a low-power, low-cost counter for use within a process area for more reliable radioactivity-contamination control. (auth)

9275 SIMULTANEOUS NEUTRON ACTIVATION DETERMINATION OF Cu, Zn, AND Mn IN PLANT MATERIALS. Dubinskaya, N. A.; Kyun'ke, L. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 3-7(1972). (In Russian).

A possibility of simultaneous neutron activation determination of Cu, Zn, and Mn in some plant materials has been studied. The procedure is based on the group extraction of metals with 8-mercaptoquinoline and the following γ-ray spectroscopy using a Ge(Li)-detector. The sensitivity of the method is found to be equal to 5×10^{-9} g Cu, ~2.2×10^{-7} g Zn, and 6×10^{-9} g Mn. (auth)

9276 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF Co AND SOME OTHER ELEMENTS IN PLANT MATERIALS. Dubinskaya, N. A.; Kyun'ke, L. M. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 8-13(1972). (In Russian).

A possibility of the nondestructive neutron activation analysis of Co as well as Fe, Zn, and Rb in some plant materials using a Ge(Li) detector has been studied. The limit of the detection for 8 plant materials has been determined as (1.7 to 13) 10^{-3} ppm Co for irradiation, cooling, and measurement conditions used. Potential sources of errors are discussed. (auth)

9277 NONDESTRUCTIVE NEUTRON ACTIVATION ANALYSIS OF TROILITE. Lyul, A. Yu. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 14-17(1972). (In Russian).

Nondestructive neutron activation analysis of troilite (FeS) has been studied. The detection limits of V, Mn, Co, Cu, Cr, and Al are given. (auth)

9278 NEUTRON ACTIVATION METHOD FOR THE DETERMINATION OF TUNGSTEN IN ORES AND IN THEIR REPROCESSING PRODUCTS USING A LINAC. Abbosov, O.; Abrams, I. A.; Pelekis, L. L.; Starchik, L. P. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 18-22(1972). (In Russian).

A neutron activation method for the determination of tungsten in ores and in their reprocessing products using neutrons obtained by means of the linac (E = 5 MeV, i = 0.7 ma) bremsstrahlung and the beryllium target is described. The sensitivity limit using a short-lived isotope ^{183m}W is 1×10^{-20}% and 0.8×10^{-4}% for a long-lived isotope ^{187}W. The time needed for the analysis of the sample does not exceed 2 minutes in the first case. (auth)

9279 DETERMINATION OF OXYGEN AND NITROGEN USING A (p,α) REACTION IN A CYCLOTRON. Mukhamedov, S.; Akabirov, B.; Vakilova, G.; (and others) (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 9, 30-3(1971). (In Russian).

Oxygen and nitrogen was determined in Ta, and O in Al, by irradiating samples of Ta or Al in a 150-cm cyclotron with 18-MeV protons so as to obtain the (p,α) reactions required. Removal of the samples from the target holder and dissolution of up to 25 μ of the surface metal in HNO_3–HF etching solution required 10 min. The active products of the (p,α) reaction, ^{13}N and ^{11}C, are positron emitters (10.1- and 20.4-min). A pair of scintillation detectors (NaI(Tl) crystal) was used to determine the decay curve which could be interpreted in terms of the quantity of O and N originally in the sample. (K.S.W.)

9280 DETERMINATION OF GAS CONTENT IN PRECIOUS METAL FILMS BY NEUTRON ACTIVATION ANALYSIS. Mueller, G. F. P. Kerntechnik; 14: No. 9, 398-401(Sep 1972). (In German and English).

Activation analysis is a useful method for determining small gas quantities in precious metal films and other deposits on material surfaces. The film deposition method by cathodic pulverization makes use of argon which, together with certain residual gases, becomes trapped in the film and affects its properties. The analysis procedure is described. The advantage of the neutron activation method is that it is a nondestructive analysis method and usually does not require separation of the film. (auth)

9281 RAPID RADIOCHEMICAL SEPARATION AND DETERMINATION OF GALLIUM IN COAL ASH. Santoliquido, P. M.; Ruch, R. R. (Illinois State Geological Survey, Urbana). Radiochem. Radioanal. Lett.; 12: No. 1, 71-6(9 Nov 1972).

Gallium in low-temperature coal ash was determined by neutron activation analysis with radiochemical separation. The procedure involves alkaline fusion, coprecipitation, and solvent extraction. U. S. Geological Survey standard rock W-1 was analyzed to check the accuracy of the method. The gallium content of eight Illinois coals ranges from 3.0 to 8.0 ppM. National Bureau of Standards coal SRM-1630 contains 1.07 ± 0.04 ppM gallium. (auth)

9282 DETERMINATION OF FLUORINE AND OF OXYGEN IN THE PRESENCE OF FLUORINE BY SELECTIVE NEUTRON ACTIVATION USING ^{252}Cf AND A 14-MeV GENERATOR. Lauff, J. J.; Champlin, E. R.; Przybylowicz, E. P. (Eastman Kodak Co., Rochester, NY). Anal. Chem.; 45: No. 1, 52-7(Jan 1973).

A method was developed for neutron activation analysis of fluorine using a ^{252}Cf neutron source. In addition, a differential method was developed for the analysis of oxygen in the presence of fluorine by the complementary use of a ^{252}Cf neutron source and a 14-MeV neutron generator. The sensitivity for the fluorine determination is 0.4 mg fluorine in a 10-g sample; that for oxygen is 0.04 mg. Both methods are nondestructive, interference-free, and applicable to either organic or inorganic matrices. A precision of 1% is obtained for the macrolevel fluorine determination and 2% or more for the differential oxygen measurement. Fluorine analyses of the same materials by a spectrophotometric method and by neutron activation with ^{252}Cf provide a basis for comparison of the two methods. The ^{252}Cf procedure yields results with better precision and accuracy based on fewer determinations, although a much larger sample (1 g) is required. (auth)

9283 RAPID DETERMINATION OF MATRIX COMPONENTS BY NEUTRON ACTIVATION ANALYSIS: THE ANALYSIS OF GOLD ALLOYS. Heurtebise, M.; Montoloy, F.; Lubkowitz, J. A. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Anal. Chem.; 45: No. 1, 47-52(Jan 1973).

The possibility of analyzing the macroconstituents of a matrix by using neutron activation without utilizing any standards was studied, provided all major constituents can be activated and detected. Equations were derived that directly relate the concentration of each of the constituents to the ratio variations of the accumulated counts due to the activation of these elements present. The general theory was successfully applied to the determination of gold alloy constituents. A relative standard deviation of 0.92, 3.3, and 0.91% was obtained for gold, silver, and copper determinations, respectively. Average deviation of the results obtained by this method and atomic absorption was 0.58%. (auth)

9284 INSTRUMENTAL ACTIVATION ANALYSIS OF PRINCIPAL PROGENITORS OF COSMOGENIC NUCLIDES. Parekh, P. P.; Heimann, M.; Herr, W. (Univ., Cologne). Radiochem. Radioanal. Lett.; 12: No. 2-3, 153-62(29 Nov 1972).

Using reactor and 14-MeV neutron activation, 9 major and minor constituents in 17 chondrites, viz., Na, Mg, Al, Si, Cr, Fe, Co, Ni, and Mn, were determined by a sequential scheme involving alternate irradiation and cooling. The first 8 elements are the principal targets for the cosmic-ray-produced ^{21}Ne, ^{22}Na, ^{26}Al, ^{53}Mn, ^{59}Ni, and ^{60}Co found in stony meteorites. On the basis of literature data, equations correlating the content of the spallogenic nuclides with that of the main target elements of chondrites are given. (auth)

Chemical and Spectral Procedures

9285 (FOA-4-4501-A-2) METHOD FOR THE DETERMINATION OF HYDROGEN, NITROGEN, AND OXYGEN IN PLUTONIUM BY VACUUM FUSION-GAS CHROMATOGRAPHY. Alm, K.-F.; Andersson, L.-H. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jun 1972. 13p. Dep. NTIS (U. S. Sales Only).

A method for determination of hydrogen, nitrogen, and oxygen in plutonium metal by a vacuum fusion technique is given. The analytical system was connected with an induction–heated graphite crucible in a high-vacuum system in a glove box for the safe handling of plutonium. The sample reacts with graphite dissolved in a liquid-metal (platinum) bath at high temperature. The gases evolved are transferred to the analytical system by means of a mercury diffusion pump. The volume of the gaseous sample is measured in the buret of an automatic Toepler-pump and then analyzed in a gas chromatograph. Evaluation of the method shows that the limits of detection of the three elements are of the order of 0.8 μg hydrogen, 3.0 μg nitrogen, and 2.5 μg oxygen. (auth)

9286 (LFEN–137-a) QUANTITATIVE DETERMINATION OF ALUMINUM IN ALLOYS OF ALUMINUM, NIOBIUM, AND SILICON. Pimenta, A. B. S.; Coelho, C. J. M. (Junta de Energia Nuclear,

Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1972. 16p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A method is described for determining the aluminum content in alloys of aluminum, niobium, and silicon, using an oxine in chloroform as reagent. The colored compound obtained obeys Beer's law to 100 μg of aluminum. A study is made of the number of extractions necessary for the quantitative determination of the aluminum content and the validity of the hypotheses made is checked experimentally. An analysis is also made of the influence of sulfite and the way to eliminate niobium interference. (auth)

9287 PROBLEM OF THE LOSS OF MOLYBDENUM DURING THE ANALYSIS C_3 TUNGSTEN METAL FOR TRACES OF MOLYBDENUM. Lassner, E.; Schedle, H. (Metallwerk Plansee, Reutte/Tyrol, Austria). Talanta; 19: No. 12, 1670-1(Dec 1972). (In German).

It is shown that oxidative ignition of metallic tungsten to tungsten trioxide causes a decrease in the molybdenum content. Thus the ignition cannot be used when the molybdenum content is to be determined. On the other hand, when the tungsten is dissolved in a mixture of hydrofluoric and nitric acids with subsequent fuming with sulphuric acid, no such decrease in the molybdenum content takes place. (auth)

9288 SPECTRAL ANALYSIS OF CONCENTRATES AND PREPARATIONS OF GADOLINIUM, DYSPROSIUM, AND YTTRIUM. Fadeeva, L. A.; Karpenko, L. I. Zh. Prikl. Spektrosk.; 16: No. 5, 903-5(May 1972). (In Russian).

The spark method of analysis was applied to solutions for the determination of mixtures of rare earth elements (Y, La, and the lanthanides) with high sensitivity. The method was based on the measurement of the relative intensity of lines of the rare earth elements in a given sample, as compared with the corresponding lines from a reference standard containing known concentrations of the elements sought. A composite porous electrode was used to introduce the solution to the zone of the discharge. The coefficient of variation was 8 to 10%. The method has been confirmed for the analysis of synthetic and technical samples. (tr-auth).

9289 PAPER CHROMATOGRAPHIC SEPARATION AND PHOTOMETRIC DETERMINATION OF NIOBIUM AND TANTALUM IN STEEL. Tietze, B. (Physical-Chemical Lab., Giessen, Ger.). Mikrochim. Acta; No. 5, 658-63(1972). (In German).

The Rf values of niobium and tantalum obtained when using different paper chromatographic methods are known. The Rf values have been compared with those obtained with the circular method. This method is used for the quantitative analysis of niobium and tantalum in steels. (auth)

9290 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM(VI) WITH CHROMAZUROL S AND CETYLPYRIDINIUM BROMIDE. Leong, C. L. (National Inst. for Scientific and Industrial Research, Selangor, Malaysia). Anal. Chem.; 45: No. 1, 201-3(Jan 1973).

A spectrophotometric method for determining U(VI) with Chrom Azurol S and cetylpyridinium bromide that utilizes the reaction's high molar absorptivity of 9.9×10^4. Beer's law is obeyed at least up to 2.0 μg U(VI)/ml. The relative standard deviation is 3.0%. (D.H.M.)

9291 PREPARATION OF ZIRCONIUM β-DIKETONATE COMPLEXES FROM ZIRCONIUM ORES. Tsuge, S.; Leary, J. J.; Isenhour, T. L. (Univ. of North Carolina, Chapel Hill). Anal. Chem.; 45: No. 1, 198-200(Jan 1973).

A new more general method is described for the synthesis of zirconium β-diketonates in which the very intractable mineral, $ZrO_2 \cdot SiO_2$, as well as ZrO_2 and $ZrCl_4$ can be converted into the volatile chelates. This method involves a borax fusion of the minerals, followed by sequential reactions with carbon tetrachloride (CCl_4) at 400°C and with the β-diketone at 110°C in a sealed glass capillary tube. Such a general preparative method is necessary when the trace analysis of zirconium in unknown minerals is to be performed via gas chromatography or mass spectrometry of the volatile β-diketonates. (auth)

9292 LASER EXCITED ATOMIC AND IONIC FLUORESCENCE OF THE RARE EARTHS IN THE NITROUS OXIDE–ACETYLENE FLAME. Omenetto, N.; Hatch, N. N.; Fraser, L. M.; Winefordner, J. D. (Univ. of Florida, Gainesville). Anal. Chem.; 45: No. 1, 195-7(Jan 1973).

The laser-excited atomic and ionic fluorescence detection limits for the rare earths in nitrous oxide–acetylene flame are presented. The atomic fluorescence detection limits are essentially the same as the best ones reported by atomic absorption spectrometry for all elements except erbium. However, because in the majority of cases, non-resonance fluorescence has been measured, atomic fluorescence should be superior to atomic absorption as far as the practical determination of rare earth mixtures is concerned. Compared with flame emission detection limits, the atomic fluorescence values are significantly inferior for Dy, Er, Eu, Ho, Nd, and Pr and are equivalent for Gd, Lu, Sm, Tb, Tm, and Yb. It was concluded that the sensitivity obtained by the laser excited atomic fluorescence should be in some cases sufficiently adequate for the determination of complex rare earth mixtures. (D.H.M.)

9293 SIMULTANEOUS SPECTROPHOTOMETRIC DETERMINATION OF BARIUM AND STRONTIUM USING SULFONAZO III. Kemp, P. J.; Williams, M. B. (Oregon State Univ., Corvallis). Anal. Chem.; 45: No. 1, 124-9(Jan 1973).

An absorbance study of the barium and strontium complexes of sulfonazo III revealed that there is no pH sensitivity of the complexes in the pH range 2.6 to 7.7. The addition of the chelons EGTA (ethylene glycol bis(aminoethyl ether)-N,N′-tetraacetic acid) and CDTA (trans-1,2-diaminocyclohexane-N,N′-tetraacetic acid) at pH 6 eliminates the interference of most cations except copper which has a light blue chelon complex. The use of EGTA at pH 6.1 and CDTA at pH 5.8 permits the determination of barium and strontium. Simultaneous equations derived from Beer's law facilitate the analysis. The working range for the method is from 1.0 to 3.0×10^{-5}M (1.4 to 4.1 ppM) for barium and from 2.0 to 8.0×10^{-5} (1.8 to 7.0 ppM) for strontium. An aqueous solution of sulfonazo III shows less than 1% decomposition in seven days. With periodic calibration, the analytical reagent can be considered stable for several months. Under these conditions, the determination is accurate to within 2% of the actual concentrations. The properties of the free reagent were also investigated, and it was found that sulfonazo III could be isolated at 99.7% purity by purification with ion exchange resins and carefully controlled drying. Pure solid sulfonazo III decomposes sharply at 222°C, is soluble in water and water miscible alcohols, and is insoluble in nonpolar organic solvents. (auth)

9294 REACTION OF RARE EARTH ELEMENTS WITH SULFONITROPHENOL C. Akhmedli, M. K.; Granovskaya, P. B.; Neimatova, R. A. Azerb. Khim. Zh.; No. 5-6, 116-22(1971). (In Russian).

The reaction between Sulfonitrophenol C(SNP) and rare earth ions was investigated. A fivefold excess of the reagent, and a pH of 2.5 gave excellent results. The spectrophotometric characteristics were similar for all rare earth complexes with SNP (λ_{opt} = 610 nm), making it possible to determine total rare earth elements with an error of about 1%. Total rare earths may thus be assayed with SNP in the presence of Al, Fe, Th, and Mg ions. (K.S.W.)

9295 DETERMINATION OF SAMARIUM BY IODIMETRIC TITRATION WITH ITS ARSENATE. Shakhtakhtinskii, G. B.; Valiev, B. S.; Guseinova, G. A. Azerb. Khim. Zh.; No. 5-6, 123-7(1971). (In Russian).

A new arsenate method for the iodimetric determination of Sm was developed with a permissible concentration range of Sm from 0.8 to 80 mg per sample. The difficultly soluble Sm arsenate was precipitated, dissolved in a strong acid, then titrated iodimetrically to assay the arsenic acid liberated. The following conditions were studied to fix the optimum: precipitation temperature, acidity of the medium, conditions for washing the precipitate, effect of excess precipitating agent, and the conditions of dissolution. Sensitivity: 8×10^{-4} g Sm. Analysis time: 30 min. (K.S.W.)

9296 METHOD AND APPARATUS FOR DETERMINING THE RELATIVE AMOUNT OF A SUBSTANCE PRESENT IN A TRANSPARENT MEDIUM. Jackson, J.; Fagan, R.; Bradshaw, D. (to Mullard Ltd.). British Patent 1,290,903. 27 Sep 1972. Filed 18 Nov 1969.

It is frequently necessary to determine the amount of a substance such as water vapor in a transparent fluid medium such as a gas, for example in the helium coolant of a nuclear reactor. In the method described a beam of radiation is passed through the gas and forms two substantially mutually perpendicular plane polarized beam components, the first component comprising a narrow band of frequencies lying within an absorption band of the contaminating substance, whilst the second component comprises a band of frequencies substantially unabsorbed by either this substance or the gas. The planes of polarization of both beam components are rotated so as to alternate between two substantially perpendicular orientations, and radiation having a predetermined plane of polarization is selectively passed in such a way that the beam components are passed alternately. The respective intensities of the beam components are then compared, the radiation present in the components being arranged so that it follows a substantially common path through the gas. The comparison gives the relative amount of contaminant in the gas. Orientation of the plane of polarization may be effected by means of a Faraday rotation device in response to an applied magnetic field, and the radia-

tion may be infrared. The required apparatus is described in detail. (UK)

Radiometric and Radiochemical Procedures

Refer also to abstracts 9622, 9624, 9625, and 9678.

9297 DIRECT OBSERVATION OF TRITIUM RETAINED BY A PLATINUM BLACK CATALYST USING A LIQUID SCINTILLATION METHOD. Paal, Z.; Thomson, S. J. (Univ. of Glasgow). Radiochem. Radioanal. Lett.; 12: No. 1, 1-6(9 Nov 1972).

The technique of scintillation counting can be used in the detection of tritium taken up and retained by platinum black catalysts. This represents a direct method of detecting a catalytically important adsorption, which is commonly inferred from difference methods. (auth)

Separation Procedures

Refer also to abstract 9955.

9298 (CEA-R-4385) DISTRIBUTION AND EXCHANGE EQUILIBRIA BETWEEN A CATIONIC ION EXCHANGER SWOLLEN WITH WATER AND A METALLIC CHELATE SOLUTION IN A WATER-IMMISCIBLE SOLVENT. Poitrenaud, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1972. 148p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis submitted to Paris Univ. (France).

Ion exchange resins do not swell much in solvents that are immiscible with water. They can be used, however, in such solvents if they have been swollen previously with water. The main parameters on which the distribution coefficient of a metallic element depends have been determined by a study of the distribution and exchange equilibria between an acidic ion exchanger (sulfonic, carboxylic, phosphonic, or aminodiacetic) and benzene solutions of metallic chelates (Cu(II), Fe(III), Al(III), and U(VI) acetylacetonates or oxinates). These parameters are: the acid-base properties of the chelating agent and its concentration in the organic solvent, the acidic strength of the resin functional groups, the concentration in the organic solvent of reagents such as amines or phosphoric esters which can shift the distribution equilibria of the metallic element. In the case of a nonbasic chelating agent and a strongly acidic exchanger the overall distribution coefficient of a metallic element can be calculated if the individual constants for both cation exchange and solvent extraction are known. The partition chromatography of metallic chelates with ion exchanger columns was studied. The efficiency of such columns is suitable only if the resin particles are small and if the flow rate of the organic eluant is low. The applications of this method to the solution of analytical separation problems are discussed. Separations of U(VI) and Cu(II) and of U(VI) and Mo(VI) by selective elution with benzene or chloroform solutions of acetylacetone are given as examples. (auth)

9299 (FEI-302) EFFECT OF INDIUM ON EXTRACTION OF MICROELEMENTS FROM BROMIDE SOLUTIONS. Sokolov, A. B.; Zolotov, Yu. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The effect of In concentration in the organic phase on the extraction of microquantities of Zn, Te(IV), Tl(III), Sn(IV), Hg, Cd, Bi, Sb(III), Ag, Co, Sc, and As(III) by TBP, MIBK, and 2,2'-dichlorodiethyl ether from 5M HBr solutions was studied. It was established that extraction of the majority of these microelements was reduced significantly by macroquantities of In, and that the distribution coefficients (D) were decreased by factors of 100 to 1000. Suppression of microelement extraction was studied as a function of HBr concentration. An explanation of a possible mechanism for the extraction behavior is offered. (tr-auth)

9300 3-THIANAPHTHENOYLTRIFLUOROACETONE: A NEW REAGENT FOR THE SOLVENT EXTRACTION OF ZIRCONIUM AND HAFNIUM. Johnston, J. R.; Holland, W. J.; Gerard, J. (Univ. of Windsor, Ont.). Mikrochim. Acta; No. 5, 608-11(1972).

A method for the solvent extraction of mg quantities of zirconium(IV) and hafnium(IV) from 3-molar perchloric acid with 3-thianaphthenoyltrifluoroacetone is described. The effects due to acidity, choice of acid, time, heating, solvents, and reagent concentration are reported. (auth)

9301 PRECONCENTRATION OF TRACE ELEMENTS BY ALUMINUM HYDROXIDE. Strohal, P.; Molnar, K.; Bacic, I. (Inst. Rudjer Boskovic, Zagreb). Mikrochim. Acta; No. 5, 586-90(1972).

Coprecipitation of traces of cobalt, zinc, chromium, ruthenium, and mercury with freshly precipitated aluminium hydroxide has been investigated by a radiotracer method. Investigations were performed over a wide range of pH. The results indicate that traces of cobalt, zinc, and chromium could be almost completely coprecipitated between pH 6 and 10. On the other hand, coprecipitation yields for ruthenium in this pH range do not exceed 95%, which is believed to be the consequence of the various physicochemical states of ruthenium. The coprecipitation yields for mercury are very low as a consequence of the presence of nonionized $HgCl_2$. (auth)

9302 DISTRIBUTION OF INORGANIC FLUORIDES BETWEEN AQUEOUS SOLUTIONS AND ALIPHATIC KETONES. Gagliardi, E.; Fuesselberger, E. (Univ., Graz). Mikrochim. Acta; No. 5, 700-6(1972). (In German).

The distribution of 30 fluorides between acidic solutions and three aliphatic ketones is described. Niobium (columbium), tantalum, and rhenium can be separated quantitatively following double extraction with butanone and transferred into the organic phase and thus isolated from numerous elements. The influence of the acidity on the extractability is shown. Simple negatively charged metal fluorocomplexes are shaken out preferably. (auth)

9303 ANION EXCHANGE SEPARATION OF ELEMENTS EXTRACTABLE WITH TRIBUTYL PHOSPHATE. I. SEPARATION OF URANIUM FROM IRON IN THE PRESENCE OF TRIBUTYL PHOSPHATE. Koch, W.; Korkisch, J. (Univ., Vienna). Mikrochim. Acta; No. 5, 687-99(1972). (In German).

A systematic study was made of the behavior of U(VI) and Fe(III) on the strongly basic anion exchanger Dowex 1,X8 (chloride form) in hydrochloric acid solvent mixtures containing TBP. The findings led to two different methods for the separation of the named elements on ion exchange columns, whereby by a combination of extraction and ion exchange it was possible to achieve a separation of the iron and the uranium also from other elements. The separations took place in media of the following composition: 30 volume % TBP, 60 volume % methylglycol and 10 volume % of 12 M hydrochloric acid as well as 40 volume % TBP–kerosene (50 volume %) and 60 volume % of an acetone–hydrochloric acid mixture (95 volume % acetone and 5 volume % 12 M hydrochloric acid). Furthermore, a method was developed for the spectrophotometric determination of iron(III) in a solvent mixture containing TBP. (auth)

9304 ANION EXCHANGE SORPTION OF N-(HYDROXYETHYL)ETHYLENEDIAMINETRIACETATE COMPLEXES OF TRIVALENT LANTHANIDES. Bruecher, E.; Toth, I. (Univ., Debrecen, Hungary). Radiochem. Radioanal. Lett.; 12: No. 1, 53-8(9 Nov 1972).

The neutral complexes of trivalent lanthanides with HEDTA are sorbed by a strongly basic anion exchange resin in the HEDTA form. Their sorption can be explained by the formation of complexes with a metal to ligand ratio of 1:2. These complexes can be formed in the solution or in the resin phase, where the concentration of HEDTA is very high. The affinity of the LnHEDTA complexes to the resin in HEDTA form is practically independent of the atomic number of the lanthanide at pH = 7.5, but the elements in the middle of the series are absorbed more strongly at pH = 4.2. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstract 9939.

Chemical and Physicochemical Properties

Refer also to abstracts 9424, 9425, and 10412.

9305 SORPTION OF GASEOUS BROMINE TRIFLUORIDE ON SODIUM FLUORIDE. Sakurai, T. (Japan Atomic Energy Research Inst., Tokai). Inorg. Chem.; 11: No. 12, 3110-12 (Dec 1972).

Since gaseous BrF_3 may be used as the fluorinating reagent and NaF has been used as the chemical trap to separate U and Pu from fission products in the fluoride volatility process in the reprocessing of nuclear fuels, it is desirable to check the interaction between BrF_3 and NaF. Results show that a weight increase obtained after 120 min was 57 mg, which was some 10^3 times the amount of BrF_3 expected for its physical or chemical adsorption on the sodium fluoride; it was therefore indicated that the sorbed BrF_3 diffused into the sodium fluoride crystal. A study of ^{18}F exchange reaction between radioactive sodium fluoride and BrF_3 showed that the fluorine atoms were exchanged through

complex formation. It was found that the weight increase was no longer detected after about 25 hr. The results show the final mole ratio of NaF/BrF_3 was 3. (D.H.M.)

9306 SIMPLE HIGH YIELD SYNTHESIS OF METHANOL-^{18}O AND ETHANOL-^{18}O. Sawyer, C. B. (Univ. of California, Berkeley). J. Org. Chem.; 37: No. 25, 4225-6(15 Dec 1972).

A simple high-yield method with negligible dilution of the label from starting $H_2\,^{18}O$ was developed. Methanol-^{18}O was prepared by hydrolysis of tributyl orthoformate and ethanol-^{18}O by hydrolysis of 1,1-dipropoxyethane and reduction of acetaldehyde produced to the alcohol. (M.C.G.)

9307 EXCESS ULTRASONIC ABSORPTION IN HEAVY WATER. Swamy, K. M.; Lakshminarayana, K.; Murty, J. S.; Swamy, P. S. (Andra Univ., Waltair, India). Phys. Lett.; 42A: No. 2, 167-8(20 Nov 1972).

The excess ultrasonic absorption in D_2O was theoretically evaluated by calculating the relaxation time τ and the relaxing compressibility β_γ. There is good agreement between the theoretical and the experimental values of excess absorption. (auth)

9308 PROCEDURE FOR CARRYING OUT CHEMICAL EXCHANGE REACTIONS. Berg, R. (to Institutt for Atomenergi). Norwegian Patent 123,491. 9 Mar 1972. Filed 19 May 1970. (In Norwegian).

A process whereby chemical exchange reactions between fluids and solid substance with a specific surface area less than 50 m^2/g, as in ion exchange reactions between e.g. methyl iodide and zirconium phosphate, may be enhanced is described. The process consists of heating the solid substance to over 300°C and then quenching it rapidly to under −75°C. Three examples are given, with experimental data, of the process, using zirconium phosphate or diatomite together with methyl iodide, sodium iodide, potassium iodide, rubidium iodide, cesium iodide and cesium chloride. (Norway)

Isotope Effects

Refer also to abstract 9418.

9309 DENSITY OF THE Ne–pH_2 AND Ne–nD_2 SOLUTIONS. Konareva, V. G. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 185-9(Feb 1972). (In Russian).

Density of the Ne–pH_2 and Ne–pD_2 solutions at 29 to 37°K within the homogeneous region over a wide concentration range was measured and excessive volumes of mixing were calculated. Expansion at a low neon concentration and compression at a high neon concentration with respect to additive volumes were observed for all the solutions studied. The behavior of these two systems is the same in this aspect though the value of the excessive volumes of mixing for the Ne–nD_2 system is smaller than that for the Ne–pH_2 system. Theoretical calculations of V^E do not agree with the experimental data. (auth)

9310 INTERMOLECULAR VIBRATIONS AND DIFFUSION IN WATER INVESTIGATED BY SCATTERING OF COLD NEUTRONS. von Blanckenhagen, P. (Institut fuer Angewandte Kernphysik, Karlsruhe, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 9, 891-903(Sep 1972).

The energy distributions of neutrons scattered by H_2O, D_2O, and some aqueous solutions were measured at temperatures between −5°C and +95°C. Quasi-elastic and inelastic scattering data were analyzed to study the diffusion mechanism and the frequency distribution of the intermolecular vibrations, respectively. The diffusion coefficients were derived from the line widths of the quasi-elastic scattering law at small momentum transfers Q. Near the boiling point they agree within 10% with the spin-echo results. In the low-temperature range, however, the neutron scattering results are greater up to 70%. The energy dependence of the quasi-elastic scattering law shows a Lorentzian shape. The Q-dependence of the integral quasi-elastic scattering law and of the line width were analyzed by application of the jump diffusion model and the globule model. The temperature dependence of the mean-square displacement of the protons shows a minimum at about 30°C. For heavy water an influence of the pair correlation of the molecules upon the quasi-elastic line width was observed. The frequency distribution in H_2O ice at −5°C shows peaks at excitation energies of 6.7 MeV and 87 MeV. The main peaks occur in the water spectra at nearly the same energies, but they are increasingly broadened with increasing temperature. (auth)

9311 trans-DIBROMODIAMMINEPLATINUM(II). AQUATION AND ISOTOPIC EXCHANGE OF BROMIDE LIGANDS WITH FREE BROMIDE AND WITH TETRABROMOPLATINATE(II). Jolley, W. H.; Smith, E. D.; Martin, D. S.; Clardy, J. C.; Woods, J. D. (Ames Lab., IA). Inorg. Chem.; 11: No. 12, 2866-72(Dec 1972).

The rate constant and equilibrium quotient for the first aquation of trans-$Pt(NH_3)_2Br_2$ were determined by pH titration techniques. At 25° and an ionic strength of 0.05 M the equilibrium quotient was found to be 3.06×10^{-5} M with $\Delta H° = 8.5$ kcal/mol. The specific aquation rate constant at 25° was 1.1×10^{-3} sec^{-1}. No evidence was found for a measurable second aquation reaction. The identity of the preparation was confirmed by x-ray diffraction. The isotopic exchange of bromide followed the rate law $R = [Pt(NH_3)_2Br_2](k_1 + k_{Br}[Br])$ where k_1 agreed with the measured aquation rate constant, and at 25° and $\mu = 0.05$ M, $k_{Br} = 1.76 \times 10^{-1}$ M^{-1} sec^{-1}. Upon the addition of $PtBr_4^{2-}$ it was shown that $PtBr_4^{2-}$ and $Pt(NH_3)_2Br_2$ exchanged bromide ligands without a Br^- intermediate. The rate constant for the ligand trading process at 15° was 3×10^{-1} M^{-1} sec^{-1}. (auth)

9312 MICROWAVE SPECTRUM, STRUCTURE, DIPOLE MOMENT, AND BARRIER TO INTERNAL ROTATION OF METHYLTRIFLUOROSILANE. Durig, J. R.; Li, Y. S.; Tong, C. C. (Univ. of South Carolina, Columbia). J. Mol. Struct.; 14: No. 2, 255-60(Nov 1972).

The rotational spectra of methyltrifluorosilane in the ground and the first three excited states of the torsional mode were investigated in the region of 12.5 to 40.0 GHz. The rotational transitions for the ^{13}C isotopic species were also measured. The following structural parameters were determined: r(CH) = 1.081 ± 0.004 Å, <HCSi = 111°1′ ± 30′, r(CSi) = 1.812 ± 0.014 Å, r(SiF) = 1.574 ± 0.007 Å, <FSiC = 112°20′ ± 1°6′. The structural parameters are compared to the corresponding ones for similar molecules. The dipole moment was determined to be 2.33 ± 0.10 D. From relative intensity measurements, the barrier to internal rotation was found to be 0.93 ± 0.09 kcal mol^{-1}; this value is consistent with the values obtained for other methylfluorosilanes. (auth)

9313 VIBRATIONAL SPECTRA AND STRUCTURES OF THE TRIHALIDE IONS. Gabes, W.; Gerding, H. (Univ., Amsterdam). J. Mol. Struct.; 14: No. 2, 267-79(Nov 1972).

The infrared and Raman spectra of both symmetric and asymmetric trihalide ions (Br_3^-, I_3^-, $BrCl_2^-$, ICl_2^-, and IBr_2^-) are presented. All fundamental vibrations for these ions are located by combining the results of Raman and infrared spectra. The splitting of bands in the spectra of the solids is interpreted in terms of factor group and isotope splitting, and many features of these spectra are explained in terms of the molecular and crystal structures of these compounds. The effects of ^{37}Cl are shown. (auth)

9314 INFRARED DISPERSION STUDIES. 11. BAND INTENSITIES AND VIBRATIONAL POLARIZATIONS OF CHLOROFORM, BROMOFORM, AND THEIR DEUTERATED ANALOGUES. Ratajczak, H. (Univ., Wroclaw); Ford, T. A.; Orville-Thomas, W. J. J. Mol. Struct.; 14: No. 2, 281-91(Nov 1972).

Refractive index data were obtained between 5000 and 20 cm^{-1} for chloroform, bromoform, and their deuterated derivatives. These dispersion data were analyzed to yield infrared band intensities and atomic polarizations. (auth)

9315 ABSOLUTE RATE CONSTANTS FOR THE REACTIONS OF $O(^3P)$ ATOMS WITH C_2H_4 AND C_2D_4. Stuhl, F.; Niki, H. (Ford Motor Co., Dearborn, MI). J. Chem. Phys.; 57: No. 12, 5403-8(15 Dec 1972).

Rate constants for the reactions of $O(^3P)$ with C_2H_4 and with C_2D_4 were determined at 298 ± 2°K using pulsed vacuum-uv photolysis. Both NO_2^* and CO_2^* chemiluminescence were used to monitor decays of O atoms. The decay rates of O atoms in the presence of a large excess of C_2H_4 or C_2D_4 were independent of the initial concentration of O atoms in the range of approximately $10^9 - 10^{12}$ O atoms cm^{-3} and were linearly dependent on the reactant concentration. From these measurements, rate constants were determined to be 6.25 (±0.63) × 10^{-13} cm^3 $molecule^{-1} \cdot sec^{-1}$ for $O + C_2H_4$, and 5.6 (±0.56) × 10^{-13} cm^3 $molecule^{-1} \cdot sec^{-1}$ for $O + C_2D_4$. The present value for $O + C_2H_4$ agrees well with that measured previously in this laboratory and confirms the validity of the pulsed vacuum-uv photolysis-chemiluminescence method. (auth)

9316 CYSTEINE-CATALYZED HYDROGEN ISOTOPE EXCHANGE AT THE 5 POSITION OF URIDYLIC ACID. Wataya, Yusuke (Tokyo Univ.); Hayatsu, Hikoya; Kawazoe, Yutaka. J. Amer. Chem. Soc.; 94: No. 25, 8927-8(13 Dec 1972).

Cysteine was found to be a very efficient catalyst for hydrogen isotope exchange of uridine 5′-phosphate at position 5. It exerts the catalytic effect by a cooperative function of the SH and amino groups. Incubation of uridine 5′-phosphate in D_2O solution containing 1.0 M L-cysteine at 37°C and PD 8.8 resulted in 100% hydrogen–deuterium exchange at the five position after 7 days, while no significant change was detected in the absence of cysteine under the same conditions. (M.C.G.)

9317 LOW-FREQUENCY VIBRATIONS IN MOLECULAR SOLIDS. XVIII. TORSIONAL MODES AND BARRIERS TO INTERNAL ROTATION OF SOME ISOPROPYL COMPOUNDS. Durig, J. R.; Player, C. M. Jr.; Li, Y. S.; Bragin, J.; Hawley, C. W. (Univ. of South Carolina, Columbia). J. Chem. Phys.; 57: No. 11, 4544-55(1 Dec 1972).

Far-infrared spectra of solid $(CH_3)_2CHCl$, $(CD_3)_2CHCl$, $(CH_3)_2CHBr$, $(CD_3)_2CDBr$, $(CH_3)_2CHI$, $(CD_3)_2CHI$, $(CH_3)_2CHCN$, $(CH_3)_2CHOH$, and $(CD_3)_2CDOD$ were studied from 33 to 500 cm^{-1}. The A′ and A″ torsional modes were observed and assigned at 248 and 283, 178 and 208, 256 and 272, 189 and 205, 246 and 253, 190 and 198, 230 and 242, 237 and 277, and 169 and 194 cm^{-1}, respectively, for the above molecules. From these assigned frequencies, the torsional barriers were calculated to be 4.48, 4.54, 4.51, 4.77, 4.11, 4.73, 3.63, 4.18, and 3.94 kcal/mole, respectively. These barrier values are compared to those obtained for some similar compounds and certain trends are noted. Some of the lattice frequencies were assigned to librational and translational motions on the basis of the isotopic shifts with deuteration. (auth)

9318 REARRANGEMENTS AND UNIMOLECULAR DECOMPOSITIONS OF BENZENOID $C_9H_{11}^+$ IONS. Uccella, N. A.; Williams, D. H. (Cambridge Univ., Eng.). J. Amer. Chem. Soc.; 94: No. 25, 8778-84(13 Dec 1972).

Ions of composition $C_9H_{11}^+$ have been generated within a mass spectrometer by electron impact. In terms of the structures of the carbonium ions believed to be generated at the threshold, the ions can be subdivided into two groups. Five ions (group 1) are generated as $PhC_3H_6^+$ units and in these ions only the six hydrogens of the C_3 side chain become equivalent before unimolecular decomposition via loss of C_2H_4, C_3H_4, and C_6H_6. In contrast, CH_4 loss from the C_3 side chains is a specific 1,2 elimination and it is concluded that the reaction occurs in an excited state in which 1,2 shifts are forbidden. Five ions (group 2) are generated as carbonium ions containing di- or trisubstituted benzene rings and side chains of only one or two carbon atoms. These group 2 ions are apparently precluded (by the nature of the initially generated structures) from undergoing any facile unimolecular decompositions, and undergo rearrangements, which render all 11 hydrogens in the ion equivalent prior to loss of C_2H_4, C_3H_4, and C_6H_6. An isotope effect discriminating against D loss in group 2 operated. (auth)

9319 DEACYLATION OF ACYL CHYMOTRYPSINS FORMED FROM AROMATIC CARBONATE DIESTERS. EVIDENCE FOR HINDERED NUCLEOPHILIC ATTACK BY HISTIDINE-57. Hutchins, J. E. C.; Fife, T. H. (Univ. of Southern California, Los Angeles). J. Amer. Chem. Soc.; 94: No. 25, 8848-54(13 Dec 1972).

The reaction of α-chymotrypsin with bis(4-nitrophenyl) carbonate proceeds via the expected acyl enzyme intermediate. Rate constants for the release of p-nitrophenol from this intermediate show a sigmoidal pH dependence, indicating participation by a group of $pK_a = 7.0$. The partial return of enzymatic activity concurrent with this process occurs with identical rate constants, but liberation of the remainder of the free enzyme occurs much more slowly. In addition to deacylation involving His-57 as a general base, nucleophilic attack by some group in the active site must also take place, forming a temporarily inactive enzyme species. Such a reaction is expected on the basis of the low pK_a (7.1) of the 4-nitrophenolate ion leaving group. The fraction of inactive enzyme produced appears to be constant in the pH range 5 to 8. Thus, both general base and nucleophilic pathways must show similar pH dependence, indicating participation by His-57 in both reactions. Comparison with the activity of imidazole as a nucleophile in the reaction with ethyl 4-nitrophenyl carbonate and 4-nitrophenyl 2,2,2-trifluoroethyl carbonate shows, however, that the proposed nucleophilic attack by histidine is markedly hindered. The isotope effect k_{H_2O}/k_{D_2O} observed for the release of p-nitrophenol from 4-nitrophenylcarbonyl α-chymotrypsin is 1.5, much lower than for deacylation of ethoxycarbonyl α-chymotrypsin (3.4), a reaction occurring exclusively by the general base catalyzed process. The lower value is in good agreement with the finding that approximately half the reaction in that case occurs by a nucleophilic attack, which does not involve rate-determining proton transfer. 4-Nitrophenyl 2,2,2-trifluoroethyl carbonate acts as a normal substrate for the enzyme, obeying Michaelis–Menten kinetics (K_m(apparent) = 1.51×10^{-6} M, $k_{cat} = 0.15$ sec^{-1} at pH 8.45). (auth)

9320 EFFECT OF DEUTERATION ON THE STRENGTH OF THE AMIDE HYDROGEN BOND. Kresheck, G. C.; Kierleber, Daniel; Albers, R. J. (Northern Illinois Univ., DeKalb). J. Amer. Chem. Soc.; 94: No. 25, 8889-92(13 Dec 1972).

The self-association of N-deuterio-N-methylacetamide in carbon tetrachloride solution was studied at 25°C by equilibrium centrifugation and the data were fit to an indefinite self-association model. The apparent weight-average molecular weight, $M_{wa,c}$ and solute concentration, c, were related to the monomer molecular weight, indefinite self-association constant, and second and third virial coefficients (M_1, k, B, and C) by the equation $M_1/M_{wa,c} = 1(1 + 4kc)^{\frac{1}{2}} + BM_1c + 2CM_1c^2$. The quantities k, BM_1, and CM_1 were found to be equal to $4.10 \pm 0.35 \times 10^4$ ml/g, $4.0 \pm 1.8 \times 10^{-2}$ ml/g, and $6.7 \pm 0.8 \times 10^{-1}$ ml^2/g^2, respectively, with c expressed in units of grams per milliliter. Slightly revised values of the same quantities for protiated N-methylacetamide were $2.36 \pm 0.12 \times 10^4$ ml/g, $2.3 \pm 0.23 \times 10^{-1}$ ml/g, and $6.3 \pm 1.2 \times 10^{-1}$ ml^2/g^2, respectively. It is shown that the effect of deuteration on previously observed thermal transition curves for poly-γ-benzyl-L-glutamate is consistent with earlier interpretations which emphasized the importance of hydrogen bonds. (auth)

9321 FAR INFRARED ROTATIONAL TRANSITIONS OF AMMONIA IN AN ARGON MATRIX. Cugley, J. A.; Pullin, A. D. E. (Monash Univ., Clayton, Australia). Chem. Phys. Lett.; 17: No. 3, 406-9(1 Dec 1972).

Infrared spectra of NH_3 and ND_3 trapped in an argon matrix were studied in the 10 to 50 cm^{-1} region. Temperature variation from 13 to 20°K is used to characterize the observed bands as due to rotation of the NH_3, or ND_3, molecule. (auth)

9322 DEACTIVATION BY PROTON TRANSFER IN THE EXCITED STATE. Foerster, Th. (Univ., Stuttgart). Chem. Phys. Lett.; 17: No. 3, 309-11(1 Dec 1972).

The spectral turnover from molecular to cationic fluorescence of 2-naphthylamine in sulfuric acid–water mixtures is accompanied by strong quenching of both components. Within the turnover region deuteration increases the fluorescence quantum yields considerably. It was concluded that in this system proton transfer participates in the internal conversion process responsible for quenching. Two possible mechanisms for this are indicated. (auth)

9323 BROMINATION OF PERDEUTERIONAPHTHALENE. Ehrlich, A.; Berliner, E. (Bryn Mawr Coll., PA). J. Org. Chem.; 37: No. 25, 4186-8(15 Dec 1972).

The bromination was carried out in 50% aqueous acetic acid in which the bromide ion concentration was varied over the range from 0.1 to 0.8 M. Results were compared with previous studies on naphthalene. The ratio $(k_1)_H/(k_1)_D = 0.829$ and the reaction has a secondary inverse isotope effect. The isotope effect increased with bromide ion concentration increases. (M.C.G.)

9324 SOLVOLYSIS AND REARRANGEMENT OF 2-PHENYLETHYL TOSYLATE IN TRIFLUOROETHANOL. Noyce, D. S.; Castenson, R. L.; Meyers, D. A. (Univ. of California, Berkeley). J. Org. Chem.; 37: No. 25, 4222-3(15 Dec 1972).

Isotopically substituted 1,2-phenyl-1,1-d_2-ethyl tosylate showed essentially complete scrambling in the products of solvolysis. The secondary deuterium isotope effect on the rate was large, $k_H/k_D = 1.21$, which was apparently near maximum. (M.C.G.)

9325 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 1. GENERAL ACID CATALYSIS AND THE BROENSTED COEFFICIENTS. Albery, W. J.; Campbell-Crawford, A. N.; Hobbs, K. S. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2180-5(1972).

The acid-catalysed decompositions of 3-diazobutan-2-one and of ethyl diazopropionate show general acid catalysis. Data are reported for both compounds for a series of carboxylic acids and for H_3O^+ as catalysts. The Brønsted coefficient is 0.61 for 3-diazobutan-2-one and 0.59 for ethyl diazopropionate. The difference in the uv spectra between diazo-ketones and diazo-esters is also discussed. (auth)

9326 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 2. EXPERIMENTS AT HIGH BUFFER CONCENTRATIONS. Albery, W. J.; Curran, J. S.; Campbell-Crawford, A. N. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2185-9(1972).

The general acid-catalyzed decomposition of 3-diazobutan-2-one and ethyl diazopropionate exhibits a decrease in the expected rate as the buffer concentration is increased. This decrease is attributed to the second step in the reaction, the loss of nitrogen, becoming partially rate-determining. The free-energy difference between the transition states has been determined for both compounds. For 3-diazobutan-2-one the solvent isotope effect in the second transition state confirms the analysis. An alternative explanation of the decrease in rate in terms of the dimerisation and association of the buffer species is considered but it is shown that all the data for the hydrolysis of cyanoketen dimethyl acetal can be fitted to the second transition state hypothesis with only one extra parameter. The solvent isotope effect indicates that in this case, the second transition state involves a proton transfer which is similar to the rate-determining step in the hydrolysis of ethyl orthocarbonate. (auth)

9327 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 3. SOLVENT ISOTOPE EFFECTS FOR 3-DIAZOBUTAN-2-ONE AND ETHYL DIAZOPROPIONATE. Albery, W. J.; Campbell-Crawford, A. N. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2190-7(1972).

Data are reported for the isotopic analysis of the products of the acid-catalysed decomposition of 3-diazobutan-2-one and ethyl diazopropionate and for the rate of reaction for both compounds in mixtures of H_2O and D_2O. The kinetic data are analyzed to obtain the fractionation factors for the proton transferred to carbon and for the two secondary solvent protons. The fractionation factors from the product analysis agree with the factors for the proton transferred to carbon. A simple analytical correction for the breakdown of the rule of the geometric mean which will hold for most A-S_E2 transition states is presented and applied to the data. The data for 3-diazobutan-2-one were obtained by the differential method and their higher precision allows the investigation of models other than the simple one for the A-S_E2 transition state and in particular the inclusion of transition-state solvation terms. The results are not completely conclusive but suggest that the simple model is the most probable one. The values of α deduced from the secondary solvent isotope effect do not agree with those from the Brønsted catalysis law. (auth)

9328 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 4. PRIMARY ISOTOPE EFFECTS IN GENERAL ACID CATALYSIS. Albery, W. J.; Campbell-Crawford, A. N.; Stevenson, R. W. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2198-2203(1972).

Data are presented for the solvent isotope effect on the decomposition of 3-diazobutan-2-one and of ethyl diazopropionate catalysed respectively by pyridinium ion and by acetic acid, together with data on the isotopic content of the products of the reactions. The agreement between the kinetic and product data shows that there is direct proton transfer from the acid to the diazo-compound, although there is probably also a small contribution from terms describing the solvation of the transition state. Four different models involving proton transfer through a solvent bridge are considered and rejected. Results for the decomposition of 3-diazobutan-2-one in basic solutions of H_2O and D_2O show that there is a direct reaction with water in which the OH- formed in the proton-transfer step acts immediately as a nucleophile in the second step. (auth)

9329 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 5. SECONDARY ISOTOPE EFFECTS IN GENERAL ACID CATALYSIS. Albery, W. J.; Bridgeland, J. R.; Curran, J. S. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2203-6(1972).

Data are reported for the secondary isotope effect on the reaction of 3-diazobutan-2-one with CH_3CO_2H and HCO_2H. The data obtained by the differential method are accurate enough to determine an isotopic α_{HA} from the relationship $(k_D/k_H) = (K_D/K_H)\alpha_{HA}$. The isotope substitution differentiates the Brønsted plot and the values of α_{HA} agree with the α_B found from the conventional Brønsted plot for the carboxylic acids. (auth)

9330 KINETIC ISOTOPE EFFECTS AND ALIPHATIC DIAZO-COMPOUNDS. Pt. 6. THE VALUES OF α AND THE MARCUS THEORY. Albery, W. J.; Campbell-Crawford, A. N.; Curran, J. S. (Physical Chemistry Lab., Oxford). J. Chem. Soc., Perkin Trans., II; No. 14, 2206-14(1972).

The collected data for proton transfer to three diazo-compounds, namely diazoacetate anion, 3-diazobutan-2-one, and ethyl diazopropionate, show that although the rates of the reactions are different the details of the proton-transfer part of the reaction are very similar. This qualitative conclusion is reinforced by quantitative analysis according to the Marcus theory (J. Phys. Chem.; 72: 891 (1968)). The Brønsted α changes if the catalyst is changed but not if the diazocompound is changed. This difference is connected with the difference between C bases and O and N bases. A model in which the acid strengths of the C base varies continuously with the solvation co-ordinate is examined and rejected. An extended version of the Marcus expression is developed and it is shown that the diazo-systems and the protonation of nitro-compounds, for which α_S is negative, can be successfully described by the extended theory. The data for the nucleophilic attack in the second step of the decomposition of the three diazo-compounds are compared and the suggested differences in mechanism between diazoacetate anion and 3-diazobutan-2-one are shown to be reasonable. (auth)

9331 INDUCTIVE AND FIELD EFFECTS IN AROMATIC SUBSTITUTION. Pt. 6. THE KINETICS OF HYDROGEN ISOTOPE EXCHANGE IN QUATERNARY SALTS OF DIAZACYCLOPHANES AND IN THE RELATED UNBRIDGED IONS. Danieli, R.; Ricci, A.; Ridd, J. H. J. Chem. Soc., Perkin Trans., II; No. 14, 2107-10(1972).

The kinetics of hydrogen isotope exchange between deuteriosulphuric acid and the aromatic protons of diquaternary ions belonging to the series (n = 1 to 3):

$R_3\overset{+}{N}[CH_2]_n-\langle\bigcirc\rangle-[CH_2]_n\overset{+}{N}R_3$ and (n = 2 or 3): $R_2\overset{+}{N}-[CH_2]_m-\overset{+}{N}R_2$

$[CH_2]_n-\langle\bigcirc\rangle-[CH_2]_n$

have been studied by NMR spectroscopy. A logarithmic plot of the rates of hydrogen isotope exchange against the rates of the corresponding nitration reactions is linear with a slope of 1.5. This relationship supports the view that steric hindrance is not a major factor in determining the deactivation of the bridged ions relative to the open-chain ions for a given value of n. This deactivation is attributed to the greater field effect of the nitrogen poles in the bridged ions. (auth)

9332 KINETIC SALT EFFECT IN THE ^{18}O-EXCHANGE REACTION BETWEEN BROMATE AND WATER. Gamsjaeger, H.; Baertschi, P. (Univ., Bern). Helv. Chim. Acta; 55: No. 6, 2154-9(1972).

The kinetic salt effect in the ^{18}O-exchange reaction between bromate ion and water was investigated at 60°C in a range of ionic strength from $0.02M < I < 1.9M$ using $NaNO_3$ or $NaClO_4$ as inert salts. From the experimental data the following relation was deduced for the uncatalyzed reaction path $\log k_0 = -5.736 - 0.061 \cdot I$. In the H^+-catalyzed reaction path the Brønsted–Davies equation was obeyed up to $I \simeq 0.1M$ $\log k_2 = -0.70 - 1.1[I^{\frac{1}{2}}/(1 + I^{\frac{1}{2}}) - 0.3\ I]$. At $I > 0.8M$ the sign of $\Delta \log k_2/\Delta I^{\frac{1}{2}}$ was positive. The theoretical interpretation of these results is consistent with the mechanistic evidence obtained previously from the rate law and the solvent isotope effects. (auth)

9333 INTRAMOLECULAR AMINOLYSIS OF AMIDES. EFFECTS OF ELECTRONIC VARIATION IN THE ATTACKING AND LEAVING GROUPS. Kirk, K. L.; Cohen, L. A. (National Institutes of Health, Bethesda, MD). J. Amer. Chem. Soc.; 94: No. 23, 8142-7(15 Nov 1972).

The kinetics of lactam formation from a series of o-aminophenoxyacetamides has been studied at 52°C. The rate of reaction increases with the acidity of the medium, reaching an essentially constant value below pH 3. The cyclization is catalyzed by formate and acetate buffer species; above pH 5, the rate decreases rapidly, no reaction being observed in alkaline media. A variety of kinetically equivalent mechanisms are considered, the favored mechanism being one in which the aniline base and an external proton source (general acid) attack the amide bond in concert. The observations of buffer catalysis and a Brønsted slope of 0.6 exclude consideration of a four-center electrophilic-nucleopilic mechanism or of one involving a preequilibrium protonation of the amide bond. Variation in the pK_a of the attacking aniline group provides ρ values of ca. −2.3 for catalysis by acetic acid and −2.0 for catalysis by hydronium ion. Variation in the pK_a of the leaving amine provides ρ values of +0.60 (for acetic acid catalysis) and +0.25 (for hydronium ion catalysis). Nominal solvent deuterium-isotope effects (1.3 to 1.9) are observed. While isotope incorporation from $H_2{}^{18}O$ is not observed in lactam formed at pH 3.7, incorporation (or exchange) does occur in 1 N hydrochloric acid. Values of the activation entropy (−14 to −18 eu) are consistent with the mechanisms proposed. (auth)

9334 STEREOCHEMICAL ASPECTS OF ETHER OXYGEN PARTICIPATION. VIII. KINETIC, POLARIMETRIC, AND DEUTERIUM ISOTOPE EFFECT ANALYSIS OF OXYGEN LONE-PAIR INVOLVEMENT DURING SOLVOLYSIS OF 8-OXABICYCLO[3.2.1] OCTAN-2-YL DERIVATIVES. Paquette, L. A.; Dunkin, I. R.; Freeman, J. P.; Storm, P. C. (Ohio State Univ., Columbus). J. Amer. Chem. Soc.; 94: No. 23, 8124-32(15 Nov 1972).

Upon solvolysis in buffered acetic acid, endo-8-oxabicyclo [3.2.1]octan-2-yl brosylate gives rise uniquely to the corresponding endo acetate. The endo acetate arising from acetolysis of chiral endo brosylate, $[\alpha]_{365}^{25}$ + 54.7°, is completely racemic. Titrimetric and polarimetric rate measurements of these reactions were made. These studies indicate the operation of R_2O-3 neighboring group participation to give a symmetrical oxonium ion which partitions itself between racemic acetate (22%) and racemic internally returned brosylate (78%). Subjection of (+)-exo-2-deuterio-endo-8-oxabicyclo[3.2.1]octan-2-yl brosylate to the same reaction conditions allows for the determination of the α-deuterium isotope effect of this ionization process. The low fractionation factor ($k_H/k_D = \sim 1.08$) is particularly compatible with the proposed high degree of internal nucleophilic assistance in the rate-determining step. The products of acetolysis of exo-8-oxabicyclo[3.2.1]octan-2-yl brosylate are derived exclusively from carbon skeletal rearrangement. The markedly divergent fates of the epimeric brosylates are discussed in the light of the above data. (auth)

9335 HYDROGEN BOND STUDIES. 71. AB INITIO CALCULATION OF THE VIBRATIONAL STRUCTURE AND EQUILIBRIUM GEOMETRY IN HF_2^- AND DF_2^-. Almloef, J. (Uppsala Univ.). Chem. Phys. Lett.: 17: No. 1, 49-52(1 Nov 1972).

MO LCAO SCF calculations were performed to investigate the molecular structure and vibrational spectrum of the bifluoride ion in its normal and deuterated form. The potential energy for nuclear motions was evaluated as a function of the molecular degrees of freedom, taking only linear geometries into account. The vibrational Schroedinger equation was solved by expanding the vibrational part of the total wavefunction as a sum of products of linear harmonic-oscillator eigenfunctions. The calculated properties are in good agreement with experiments, and even the minute effects of deuteration are well reproduced. (auth)

9336 INELASTIC INCOHERENT NEUTRON SCATTERING ON POLYCRYSTALLINE TAURINE AND α-AMINO-ISOBUTYRIC ACID. Davidovic, M.; Ratkovic, S.; Jovic, D.; Zivanovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Chem. Phys. Lett.; 17: No. 1, 53-6(1 Nov 1972).

Low frequency spectra of taurine and α-amino-iso-butyric acid were obtained by inelastic incoherent scattering of thermal neutrons. The assignment of the peak positions to rotational or vibrational modes of the functional groups (NH_3^+, CH_3 and CH_2) was simplified by working with partially deuterated compounds. (auth)

9337 RAMAN SPECTRA OF MOLECULAR CRYSTALS. LATTICE SPECTRA AND DYNAMICS OF ORTHORHOMBIC HYDROGEN AND DEUTERIUM HALIDES. Sun, T. S.; Anderson, A. (Univ. of Waterloo, Ont.). Chem. Phys. Lett.; 17: No. 1, 104-10(1 Nov 1972).

Raman spectra of the lattice regions of polycrystalline hydrogen chloride, hydrogen bromide, deuterium chloride, and deuterium bromide at 79 and 18°K are reported. The lattice modes are assigned in accordance with the known crystal structures, and their frequencies compared with those obtained from calculations based on a simple intermolecular potential. (auth)

Isotope Exchange and Isotope Separation

9338 THERMODYNAMICS OF LITHIUM-ISOTOPE-EXCHANGE REACTIONS. III. ELECTROCHEMICAL STUDIES OF EXCHANGE BETWEEN ISOTOPIC METALS AND AQUEOUS IONS. Singh, G.; Rock, P. A. (Univ. of California, Davis). J. Chem. Phys.; 57: No. 12, 5556-61(15 Dec 1972).

Results are reported for the direct experimental determination of the equilibrium constant for the lithium-isotope-exchange reaction $^7Li(s) + {}^6LiCl(aq) = {}^6Li(s) + {}^7LiCl(aq)$. This reaction was studied in an electrochemical quadruple cell without liquid junction of the type $^7Li(s)|^7LiBr(PC)|^7Li(Hg)|^7LiCl(aq)|Hg_2Cl_2(s)|Hg(l)|Hg_2Cl_2(s)|^6LiCl(aq)|^6Li(Hg)|^6LiBr(PC)|^6Li(s)$, where PC denotes the solvent propylene carbonate. The experimental value of the equilibrium constant at 296.6°K for this reaction is K = 1.046 ± 0.013. The experimental value of K is compared with values for K calculated from statistical thermodynamic theory for various model reactions. The results of these calculations are consistent with a tetrahedrally coordinated structure for aqueous lithium ions. (auth)

9339 CONFORMATIONAL PREFERENCE OF AN α-SULFINYL CARBANION. Fraser, R. R.; Schuber, F. J.; Wigfield, Y. Y. (Univ. of Ottawa). J. Amer. Chem. Soc.; 94: No. 25, 8795-9(13 Dec 1972).

The rates of base-catalyzed H–D exchange of the protons α to a sulfoxide group were measured in three conformationally fixed sulfoxides. Studies on the bridged biaryl sulfoxide revealed rates that differed 1000-fold for two protons that differ by only 40° in their dihedral angular orientation with respect to the sulfoxide group. A striking effect of solvent was noted in that the proton trans to the lone pair on sulfur exchanged four times faster than that trans to the S–O bond in tert-butyl alcohol-O-d, but 250 times slower in CD_3OD. Studies on the exo and endo isomers of 2-thiabicyclo[2.2.1]heptane 2-oxide showed that formation of the carbanion eclipsed with the lone pair on sulfur was much slower than that eclipsed with oxygen. The divergence of these results from predictions made on the basis of ab initio MO calculations is attributed to the inability of the calculations to include the effects of solvation. (auth)

9340 MEDIUM AND TEMPERATURE DEPENDENCE OF ACID-CATALYZED HYDROLYSIS OF N-METHYLATED METHYLBENZIMIDATES AND BENZOYLIMIDAZOLE. AN INVESTIGATION INTO THE MECHANISM OF AMIDE HYDROLYSIS. Smith, C. R.; Yates, Keith (Univ. of Toronto). J. Amer. Chem. soc.; 94: No. 25, 8811-17(13 Dec 1972).

The kinetics of hydrolysis of methylbenzimidate, N,O-dimethylbenzimidatium fluoroborate, and N,N,-O-trimethylbenzimidatium fluoroborate were studied in 1 to 65% aqueous sulfuric acid over the temperature range 25 to 85°C. The hydrolysis of benzoylimidazole was studied in 10 to 75% sulfuric acid over the temperature range 15 to 65°C. The benzimidates yielded esters as primary hydrolysis products in dilute acid but gave amides as products in more concentrated acids, indicating different rate-determining steps in dilute and concentrated acids. The order of reactivity with successive N-methylation was primary > secondary > tertiary and there were monotonic decreases in both the enthalpy and entropy of activation with successive N-methylation. By comparing rate constants, activation parameters, product studies, and ^{18}O exchange results for the N-methylated methylbenzimidates and the corresponding N-methylated benzamides, it is concluded that none or not all of the benzamides hydrolyze in acid solution via the accepted tetrahedral intermediate mechanism (involving an O-protonated amide) as do the benzimidates. Inspection of data for benzoylimidazole (as a model for an N-protonated amide) does not contradict this conclusion. (auth)

9341 LITHIUM ISOTOPE SEPARATION. Hagiwara, Z. (to Nippon Rensui Kabushiki Kaisha). U. S. Patent 3,701,638. 31 Oct 1972. Priority date 2 Oct 1967, Japan.

A solution containing lithium isotope ions is treated with at least one cation exchanger to cause adsorption of the lithium ions on the cation exchanger, which is then treated with an eluent in the form of a solution of a water-soluble compound of a metal other than lithium in a water on a polar solvent to cause elution of the lithium ions. (Official Gazette)

9342 ELECTRON EXCHANGE REACTIONS IN THE $^{204}Tl(I)$–Tl(III)–2,2'-DIPYRIDYL AND $^{204}Tl(I)$–Tl(III)-1,10-PHENANTHROLINE SYSTEMS. Cecal, A.; Schneider, I. A. (Al. I. Cuza Univ., Iassi). Radiochem. Radioanal. Lett.; 12: No. 1, 39-45(9 Nov 1972).

The kinetics of isotope exchange by electron transfer between Tl(I) and Tl(III) were studied with the trivalent thallium in the form of $[Tl\ dipy_2](NO_3)_3$ and $[Tl\ ph_2](NO_3)_3$ complexes. A small difference between the reactant systems $^{204}Tl(I)$-Tl(III)-2,2'-dipyridyl and $^{204}Tl(I)$-Tl(III)-1,10-phenanthroline was observed. (auth)

9343 MECHANISM OF HYDROGEN–DEUTERIUM EXCHANGE OF PROPYLENE OVER A BROENSTED ZEOLITE CATALYST. George, Z. M.; Habgood, H. W. (Research Council of Alberta, Edmonton). J. Phys. Chem.; 76: No. 26, 3940-3(21 Dec 1972).

Propylene was shown to exchange with the hydrogen of a Brønsted acid catalyst (NaY zeolite containing traces of Ca^{2+} and H^+) at 400°C. Significant exchange was found on the C2 carbon in addition to the expected exchange at C1 and C3. The relative rates of exchange and of isomerization to cyclopropane rule out the possibility of any appreciable participation of protonated cyclopropane in the reaction under these conditions. (auth)

9344 HYDROGEN–DEUTERIUM EXCHANGES IN PYRIMIDINE N-OXIDES. Krueger, S. A.; Paudler, W. W. (Ohio Univ., Athens). J. Org. Chem.: 37: No. 25, 4188-90(15 Dec 1972).

In an effort to delineate the effect that Sp^2 nitrogen atoms have on the H → D exchange rates of "Azapyridine N-oxides," the behavior of several 5-substituted pyrimidine 1-oxides when they were subjected to base-catalyzed H → D exchange. The nonoxidized nitrogen atom, when situated ortho or para to the exchanging proton, was much less effective in facilitating H → D exchange than when it was located meta to the exchanging position. The inductive effect of a 5 substituent situated ortho to the exchanging proton is the controlling factor in that exchange process. (M.C.G.)

9345 HOMOGENEOUS PLATINUM(II)-CATALYSED HYDROGEN–DEUTERIUM EXCHANGE AT A SATURATED CARBON ATOM. Masters, C. (Koninklijke/Shell-Laboratorium, Amsterdam). J. Chem. Soc., Chem. Commun.; No. 23, 1258-9(6 Dec 1972).

In the presence of a homogeneous platinum catalyst alkenes of the type $RC(CH_3)_2CH = CH_2$, (R = C_2H_5, C_3H_7, or C_4H_9) undergo hydrogen–deuterium exchange in the alkyl part of the molecule almost exclusively at C-5. (auth)

9346 EXCHANGE EQUILIBRIUM OF OXYGEN ISOTOPES BETWEEN BrO_3^-, ClO_3^-, IO_3^-, AND WATER. Agarwal, S. C.; Baertschi, P.; Gamsjaeger, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Helv. Chim. Acta; 55: No. 6, 2178-81(1972).

The liquid phase fractionation factors $\alpha_H = (^{18}O/^{16}O)_{H_2O}/(^{18}O/^{16}O)_{XO_3^-}$ and $\alpha_D = (^{18}O/^{16}O)_{D_2O}/(^{18}O/^{16}O)_{XO_3^-}$ (X = Cl, Br, I) were calculated quantum mechanically between 0 and 100°C. Experimental values were obtained in the case of BrO_3^- at 60°C showing good agreement with the calculated results.(auth)

Feed Materials Processing

9347 (DOCKET-408084-5) URANIUM CONCENTRATOR. Draft Detailed Statement on the Environmental Considerations. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 58p. Dep. NTIS.

An independent evaluation of the applicants' proposed activities at the Humeca Uranium Mill and their environmental considerations by the AEC staff is presented. The site, mine, mill, environmental impact of the proposed action, adverse effects that cannot be avoided, alternatives to the proposed action, and a benefit-cost analysis are discussed. (M.C.G.)

9348 (DOCKET-701327-2) URANIUM HEXAFLUORIDE FACILITY. Environmental Report, Revision December 15, 1972. (Allied-Gulf Nuclear Services, Barnwell, S. C.). 15 Dec 1972. 356p. Dep. NTIS.

Revisions are provided for the environmental report submitted in support of an application for license to possess and use special nuclear material, source material, and by-product material associated with the conversion of uranyl nitrate to uranium hexafluoride. New pages are provided for replacement and addition. (M.C.G.)

Radiation Chemistry

Refer also to abstracts 9423 and 11200.

9349 ELECTRON SPIN RESONANCE STUDY OF X-IRRADIATED SINGLE CRYSTALS OF THIOSEMICARBAZIDE. Claridge, R. F. C.; Greenaway, F. T. (Univ. of Canterbury, New Zealand). J. Magn. Resonance; 8: No. 4, 316-24(Dec 1972).

The ESR spectra of x-irradiated single crystals of thiosemicarbazide observed at room temperature showed hyperfine couplings to two nitrogen and two hydrogen atoms. From the known crystal structure and by comparison with deuterated thiosemicarbazide the radical was assigned as the $\cdot N_{(\alpha)}H_{(\alpha)}CSN_{(\beta)}H_{(\beta)}NH_2$ radical. (auth)

9350 STRUCTURE OF PRIMARY RADICAL PRODUCTS FORMED IN γ IRRADIATION OF POLYCRYSTALLINE POLYOLS AND MONOSACCHARIDES. Nikitin, I. V.; Miroshnichenko, I. V.; Kudryashov, L. I.; Dyatkina, M. E. (Inst. of Organic Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 2, 387-9(11 May 1972). (In Russian).

EPR spectra of some irradiated sugar alcohols and monosaccharides were determined over the temperature range 77 to 153°K. Polycrystalline hexitols (dulcitol, mannitol, and sorbitol) and pentols (arabitol, xylitol, ribitol), and hexoses (galactose, glucose, mannose) were irradiated at the specified temperature with 5 MR of ^{60}Co gamma radiation. The spectra indicated an absence of formation of radicals during irradiation as a result of rupture of C–C or C–O bonds. Primary radical products were formed in polyols and monosaccharides by radiation only as a result of rupture of C–H bonds or secondary carbon atoms. (K.S.W.)

9351 MECHANISM OF DIRECT AND INERT GAS-SENSITIZED γ-RADIOLYSIS OF CYCLOPROPANE. von Buenau, Guenther; Kuehnert, Peter (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). Ber. Bunsenges. Phys. Chem.; 76: No. 9, 913-20(Sep 1972). (In German).

Direct as well as Kr- and Xe-sensitized γ-radiolyses of cyclopropane were studied by quantitative analysis of all essential products and as a function of pressure, dose rate, and additives (NO, N_2O, SF_6). Results were subjected to a kinetic analysis from which numerical values of probabilities for individual decompositions and other elementary processes were derived. In particular, it was found, that relevant ion reactions were favored by the added rare gases. In the case of Kr-sensitization, radiolysis products are formed with rates that are significantly lower than in direct and Xe-sensitized radiolyses. This is traced to formation of unreactive $C_3H_7^+$-ions that are generated, among others, by charge transfer from Kr^+-ions to cyclopropane molecules. Xe^+-ions generate mainly $C_3H_6^+$-, $C_3H_5^+$-, and $C_3H_3^+$-ions, whereby the latter require the intermediate presence of excited Xe^+-ions. (auth)

9352 NONOSECOND PULSE RADIOLYSIS OF ACETONE. KINETIC AND THERMODYNAMIC PROPERTIES OF SOME AROMATIC RADICAL CATIONS. Rodgers, M. A. J. (Univ. of Manchester, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 7, 1278-86(1972).

Spectra of the molecular ions of acetone, formed during liquid phase pulse radiolysis are reported. The kinetic features of the monomer–dimer cation equilibria of some aromatic hydrocarbon solutes were obtained at a number of temperatures. Equilibrium constants and thermodynamic data were measured and their implications discussed. The data are compared with literature values for the analogous equilibria involving excited singlet monomers and excimers. (auth)

9353 EFFECT OF IRRADIATION ON ELECTRODE PROCESSES. 1. THE HYDROGEN ELECTRODE IN DILUTE SOLUTIONS. Airey, P. L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Chem. Soc., Faraday Trans., I; 68: No. 7, 1299-1311(1972).

The effect of ^{60}Co-γ and 1 MeV electron irradiation on the kinetics of the H_2-H^+ exchange on platinum electrodes immersed in hydrogen-saturated dilute aqueous solutions (pH 1.04 to 3.9; no supporting electrolyte) was studied. The investigation was possible since the dissolved hydrogen facilitated the efficient radical chain decomposition of the electrochemically-active radiolytic hydrogen peroxide. Two principal radiation effects were observed: (i) exchange current densities were increased by amounts which were too large to be explained by the catalytic activity of the unstable intermediates. It was therefore proposed that radiation generates electrochemically active sites by the displacement of surface metal atoms. (ii) irradiation led to small negative shifts in the rest potential, the magnitudes of which were proportional to the dose rate and to the electrode polarization resistance. The shifts were either a consequence of the fact that irradiation accelerates anodic more than cathodic processes; or were due to the establishment of mixed potentials involving the H_2-H^+ exchange (E_0 = 0.0 V) and the oxidation of radiolytic hydrogen atoms (E_0 = –2.1 V). Quantitative results favored the former explanation. (auth)

9354 OXYGEN SPECIES ADSORBED ON OXIDES. 1. FORMATION AND REACTIVITY OF $(O^-)_s$ ON MgO. Tench, A. J.; Lawson, T.; Kibblewhite, J. F. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 7, 1169-80(1972).

Nitrous oxide reacts with $F_s^+(H)$ centres (surface oxygen ion vacancies with a single trapped electron) to give $(O^-)_s^+$ ions adsorbed at the anion vacancy. The reaction, $F_s^+(H) + N_2O \rightarrow (O^-)_s^+ + N_2$ is quantitative and the reflectance spectrum indicates a band centred at 2 eV which is ascribed to the $(O^-)_s^+$ centre. Comparison of the optical transition energy calculated from the ESR data with the observed transition shows that the normally accepted value of 135 cm^{-1} for the spin-orbit coupling of the O^- ion is too low and that a value of > 200 cm^{-1} is more appropriate for the solid state. Nitrous oxide also reacts with other surface centres to give an adsorbed species which may be $(O_2^{2-})_s$ or $(O_2^-)_s$. The reaction of $(O^-)_s^+$ with hydrogen reforms the $F_s^+(H)$ centre which then reacts with more nitrous oxide; the reaction can be cycled several times. The reactions of $(O^-)_s^+$ with O_2, CO_2, alcohols and olefins are also investigated. To facilitate reference to various types of surface defects and adsorbed species a nomenclature is proposed which is compatible with a recently suggested notation for defects in bulk lattice. (auth)

9355 SEMI-EMPIRICAL UHF TREATMENT FOR THE SOLVATED ELECTRON. Ishimaru, S. (Kyoto Univ.); Yamabe, T.; Fukui, K.; Kato, H. Chem. Phys. Lett.; 17: No. 2, 264-8 (15 Nov 1972).

Solvated electrons in water, ammonia, and hydrogen fluoride were investigated by applying the cavity model which consists of four or six solvent molecules and using the UHF method with the INDO approximation. Various conclusions concerning several properties of solvated electrons, solvent molecules, and the structure of the cavity, particularly the proton spin densities of water and ammonia, were obtained. (auth)

9356 SENSITIZED TRIPLET–TRIPLET ABSORPTION OF BIPHENYLENE. Tetreau, C. (Institut du Radium, Paris); Lavalette, D.; Land, E. J.; Peradejordi, F. Chem. Phys. Lett.; 17: No. 2, 245-7(15 Nov 1972).

Triplet–triplet absorption of biphenylene was sensitized by naphthalene in pulse radiolysis and flash photolysis studies. A band was observed at 29,500 cm^{-1} and assigned to a predicted $^3B_{2u}^- \leftarrow {}^3B_{1g}^+$ transition Triplet biphenylene has a lifetime of 100 μsec in solution. Nonradiative processes are thought to affect mainly the first singlet state of biphenylene. (auth)

9357 DETERMINATION OF THE CHAIN DEVELOPMENT TIME IN THE POLYMERIZATION OF FORMALDEHYDE IN A γ-RADIATION FIELD AT 5 TO 80°K. Kiryukhin, D. P.; Kaplan, A. M.; Barkalov, I. M.; Gol'danskii, V. I. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 206: No. 1, 147-50 (1 Sep 1972). (In Russian).

The time of development of a polymer chain in formaldehyde was determined in a γ radiation (^{60}Co) field at 5 to 80°K. The time for developing one link in the chain was estimated to be 0.01 sec at 5°K, where the radiation yield of active centers was G = 1. It may be assumed that in the polymerization of formal-

dehyde at low temperatures, the chain reaction may be a free ion mechanism, or that the chain development is associated with a tunnel transfer of an electron or proton from molecule to molecule. (K.S.W.)

9358 TWO MECHANISMS OF WATER CLUSTER FORMATION IN THE IONIC BOMBARDMENT OF AN ICE FILM. Tantsyrev, G. D.; Nikolaev, E. N. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 206: No. 1, 151-4(1 Sep 1972). (In Russian).

The mechanism of formation and emission of ionic clusters was studied with a mass spectrometer in the bombardment of films of ice with 2-keV Ar^+ ions. The ice films were prepared by freezing water on Ni supports at liquid nitrogen temperature. A typical mass spectrum of the secondary ions formed consisted chiefly of peaks which corresponded to ions $H^+(H_2O)_n$, where n = 1 to 40. Two mechanisms for the formation of such solvated clusters are discussed; one of these accounted for maxima in the intensities of peaks represented by the periodicity $H_3O^+(H_2O)_{12}$, $H_3O^+(H_2O)_{24}$, and $H_3O(H_2O)_{36}$. (K.S.W.)

9359 ^{13}C HYPERFINE CONSTANT OF CH_2O^-. Laroff, G. P.; Fessenden, R. W. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 57: No. 12, 5614-15(15 Dec 1972).

A radiolysis experiment with an aqueous solution (N_2O saturated) of 2×10^{-3} M CH_3OH enriched to 61% ^{13}C was carried out at ~pH = 13 and provided readily detectable signals from $^{13}\dot{C}H_2O^-$. The value of 3.7.7 G for the hyperfine constant of ^{13}C in $\dot{C}H_2O^-$ is less than that in the undissociated form. (M.C.G.)

9360 EXPERIMENTAL EVIDENCE FOR STATISTICAL RANDOMIZATION OF HYDROGEN ATOMS IN THE ETHYL CATION. Ausloos, P. (National Bureau of Standards, Washington, DC); Rebbert, R. E.; Sieck, L. W.; Tiernan, T. O. J. Amer. Chem. Soc.; 94: No. 25, 8939-41(13 Dec 1972).

Evidence is presented for the randomization of H and D atoms in $C_2D_3H_2^+$ and $C_2H_3D_2^+$ obtained as unimolecular decomposition products by photon absorption, electron impact, or γ radiolysis. Kinetic mass spectrometry and chemical end-product analysis were used to study the problem. The proton transfer and hydride transfer results taken together can only be accounted for by a statistical scrambling of the hydrogen atoms in the ethyl cation irrespective of its structure. (M.C.G.)

9361 ELECTRON–ELECTRON DOUBLE RESONANCE DEMONSTRATION OF CROSS SATURATION BETWEEN TRAPPED ELECTRONS AND RADICALS IN γ-IRRADIATED 2-METHYL-TETRAHYDROFURAN GLASS. Yoshida, Hiroshi; Feng, D. F.; Kevan, Larry (Wayne State Univ., Detroit). J. Amer. Chem. Soc.; 94: No. 25, 8922-4(13 Dec 1972).

After γ irradiation of tetrahydro-2-methyl-furan (MTHF), the EPR signal was a superposition of a sharp single-line spectrum due to trapped electrons and a seven-line spectrum due to free radicals formed from the MTHF molecule. Electron–electron double resonance (ELDOR) was used to study the EPR spectrum. Results indicated cross saturation between the two different spin systems by showing transfer of energy from the free radical spin system to the trapped electron spin system to partially saturate it. Two possible mechanisms for this cross saturation are cross relaxation, in which direct spin–spin interaction between the two spin systems causes simultaneous spin flips in both systems with any excess energy conserved by dipolar interactions, and hot phonon production. (M.C.G.)

9362 ESR EVIDENCE FOR PROTON TUNNELING FROM A POSITIVE HOLE THROUGH INTERMOLECULAR HYDROGEN BOND IN IRRADIATED SINGLE CRYSTALS OF CARBOXYLIC ACIDS. Minakata, K.; Iwasaki, M. (Government Industrial Research Inst., Nagoya, Japan). J. Chem. Phys.; 57: No. 11, 4758-63(1 Dec 1972).

An irradiated single crystal of potassium hydrogen fumarate-d_2 ($K^+{}^-OOC-CD=CD-COOH$) gives two kinds of carboxyl radical, $^-OOC-CD=CD-COO\cdot[O_\sigma(I)]$ and $\cdot OOC-CD=CD-COOH[O_\sigma(II)]$. Evidence was obtained for $O_\sigma(I)$ being formed from the positive hole at the COOH end by proton tunneling to the neighboring COO^- group through the intermolecular hydrogen bond. The dipolar tensor calculated for the transferred proton agreed well with the observed tensor in both the principal values and directions. $O_\sigma(II)$ formed by loss of an electron from the COO^- group gives the hyperfine coupling to the proton which belongs to the neighboring COOH group. Agreement between the observed and calculated dipolar tensors was also fairly good. (auth)

9363 INITIAL IONIZATION YIELD AND SCAVENGABLE ELECTRON YIELD IN LIQUID HYDROCARBONS. Ko, H. W.; Mozumder, A. (Univ. of Notre Dame, IN). J. Chem. Phys.; 57: No. 11, 4724-8(1 Dec 1972).

A self-consistent procedure is described for calculating the W value for initial ionization. It utilized yields for energy deposition and a prescribed rule of correspondence between energy deposition and average number of ionizations created in an event. A value of 21.5 eV was obtained for W in hydrocarbons using Mozumder and Magee's distribution for energy deposition. It is postulated that a certain fraction of ionized electrons will be neutralized before thermalization occurs resulting in a nontrivial difference between initial ionization yield and scavengable electron yield. A superposition model is proposed to calculate the unscavengable part of the ionization yield. Present computations give G values (100 eV yield) for initial ionization and scavengable electrons as 4.65 and 4.10, respectively. (auth)

9364 LOW TEMPERATURE RADIOLYSIS OF LIQUID AMMONIA. Blum, A.; Broszkiewicz, R. K. (Inst. of Nuclear Research, Warsaw). Radiochem. Radioanal. Lett.; 12: No. 1, 15-25(9 Nov 1972).

Liquid ammonia was γ-irradiated at -72 ± 3°C with doses of $3 \times 10^{19}-2 \times 10^{20}$ eV/g. The yields are: $G(H_2) = 0.85 \pm 0.04$, $G(N_2) = 0.12 \pm 0.01$, $G(N_2H_4) = 0.12 \pm 0.02$, $G(\overline{N_3}) = 0.05 \pm 0.03$. Contrary to room-temperature results, hydrazine does not reach a steady-state concentration. The observed deficiency in the material balance, not taking into account the azide, is compared with those calculated from the literature data. The explanation of the results is based on changes in the kinetics of the secondary and tertiary reactions, partially caused by the greater stability of diimide at low temperatures. (auth)

9365 ENDOR STUDY OF THE 2-ADAMANTYL RADICAL. Lloyd, R. V.; Rogers, M. T. (Michigan State Univ., East Lansing). Chem. Phys. Lett.; 17: No. 1, 428-30(1 Dec 1972). (COO-1385-45).

The ENDOR spectrum of the 2-adamantyl radical in γ-irradiated adamantane reveals a proton hyperfine splitting of ±3.55 G. This was assigned to the δ bridgehead protons on the basis of INDO calculations. A maximum value of a_H^β from the ENDOR spectrum was used to estimate a maximum value of $B_0 \approx 0.8$ G for the widely employed relationship $a_H^\beta = B_0 + B_2 \cos^2\theta$ relating dihedral angle to proton hyperfine interactions in π electron radicals. No evidence for other radicals in γ-irradiated adamantane was obtained. (auth)

9366 YIELD OF SOLVENT EXCITED STATES IN THE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS. Baxendale, J. H.; Mayer, J. (Univ. of Manchester, Eng.). Chem. Phys. Lett.; 17: No. 3, 458-60(1 Dec 1972).

It was confirmed by pulse radiolysis that emitting solvent excited states are produced in the radiolysis of n-hexane, methylcyclohexane, and cyclohexane. The emission is quenched by benzene and benzene emission appears. Applying Stern–Volmer kinetics to emissions from solvent, benzene, and toluene in cyclohexane a very high energy transfer rate constant, viz., $k = 2.8 \times 10^{11}$ M^{-1} sec^{-1} was obtained. The yield of the excited state of cyclohexane was not greater than 0.3, and it was concluded that the major part of the excited states of other aromatics produced in cyclohexane solutions comes from ion neutralization. (auth)

9367 KINETIC ANALYSIS OF THE RADIATION POLYMERIZATION OF METHYL METHACRYLATE-KAOLIN CLAY COMPOSITES. Beeson, J. J.; Mayhan, K. G. (Univ. of Missouri, Rolla). J. Appl. Polym. Sci.; 16: No. 11, 2765-75 (Nov 1972).

In the first of a two-part series, a kinetic study was made on the effects of gamma rays (^{60}Co) in air and inert gas on the polymerization of a 50 : 50 weight-mixture methyl methacrylate (MMA)–kaolin clay system. The effect of dose rate (7.35 to 24.9 rads/sec), temperature (25 to 75°C), and total dose on the percentage conversion of monomer to polymer was studied. The rate of formation of polymer at 25°C in the composite system was found to be faster when compared to a bulk MMA system at the same dose rate. This acceleration showed that the clay had a catalytic effect on the formation of polymer. The effect decreased as temperature increased. Two types of poly(methyl methacrylate) (PMMA) were formed in the composite. One type was called homopolymer and could be removed from the composite by extraction with organic solvents. The other type was called inserted polymer and could only be removed by dissolving the clay matrix with hydrofluoric acid. The total polymer conversion was the summation of these two types of polymer formed. The kinetic analysis examined the orders of reaction and activation energies of the homopolymer, inserted polymer, and total polymer. The initial reaction orders of the homopolymer and total polymer based on dose were −0.46 and −0.49, respectively. These indicate a definite free radical reaction. The reaction order of the inserted polymer was temperature dependent. The activation energies for the homopolymer and total polymer in both atmospheres were approximately 1 kcal/mole less than the bulk activation energy at the same conditions. The inserted polymer had an activation energy that was dose rate dependent. (auth)

9368 CHARACTERIZATION OF POLY(METHYL METHACRYLATE) FROM RADIATION-INDUCED POLYMERIZATION IN THE PRESENCE OF A KAOLIN CLAY SUBSTRATE. Beeson, J. J.; Mayhan, K. G. (Univ. of Missouri, Rolla). J. Appl. Polym. Sci.; 16: No. 11, 2777-94(Nov 1972).

Two types of polymer are formed in the radio-initiated polymerization of methyl methacrylate (MMA)–kaolin clay complexes. Homopolymer can be extracted from the complex by the use of organic solvents. Inserted polymer must be removed by dissolution of the polymer–clay complex with hydrofluoric acid. The polymers formed show no differences in structure (as determined by infrared analysis), had high molecular weights (1 to 5×10^6), and had similar molecular weight distributions (as determined by GPC). The molecular weights of the homopolymer increased as temperature increased (25 to 75°C), and dose rate decreased (24.9 to 7.35 rads/sec). The isotacticity of the polymers when compared to irradiated bulk polymer decreased as follows: inserted > homo > bulk. The compressive properties of the irradiated composite compared well with those of commercial bulk polymers. Degradation temperatures were 20° to 30°C higher for the composite than for the commercial chemically initiated bulk polymer. (auth)

9369 MOLECULAR SIEVES AS DRYING AGENTS FOR THE MONOMER IN THE RADIATION-INDUCED IONIC POLYMERIZATION OF LIQUID VINYL MONOMERS. Stannett, V. T.; Du Plessis, T. A.; Goineau, A. M. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 16: No. 11, 2847-52(Nov 1972).

The factors that influence the drying of liquid vinyl monomers (such as isobutyl vinyl ether) with molecular sieves are discussed. Best results were obtained by drying the monomer for at least 12 hr at –15°C on molecular sieves that received no pretreatment at elevated temperatures. Although prepolymerization that takes place on the molecular sieves during the drying can be quite extensive, the excellent reproducibility that can be achieved by using this method makes it a promising drying technique. (auth)

9370 ELECTRON SPIN RESONANCE INVESTIGATION OF THE REACTIONS IN IRRADIATED AQUEOUS SOLUTIONS OF HYDROGEN CYANIDE AND THE CYANIDE ION. Behar, D.; Fessenden, R. W. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 26, 3945-50(21 Dec 1972).

Use of the in situ radiolysis–ESR method showed that the reactions of H and OH with HCN in acid solutions yield the radicals $H_2C=N$ ($\alpha^H = 87.2$, $\alpha^N = 10.2$ G, g = 2.0028) and HC(OH) = N ($\alpha^H = 54.40$, $\alpha^H_{OH} = 0.89$, $\alpha^N = 10.14$ G, g = 2.00322), respectively. The pK for the dissociation of the OH proton in the latter radical is estimated to be ~5. Scavenging of e^-_{aq} with HCN also yields $H_2C=N$. The reaction of OH and O^- with CN^- in alkaline solutions produced the radical $\cdot CONH_2$ as observed either directly at pH ~ 10 or by radical trapping with $CH_2=NO_2^-$ at higher pH. Exactly parallel behavior was found for CN^- and $HCONH_2$ in basic solutions. However, $HCONH_2$ yielded only $\cdot CONH_2$ in acid and neutral solutions and no rearrangement of this radical to HC(OH) =N was found. The adduct to $CH_2=NO_2^-$ found in CN^- solutions and previously identified as $NCCH_2NO_2^-$ must now be assigned the structure $H_2NCOCH_2NO_2^-$. (auth)

9371 PROCESS FOR RADIATION CROSS-LINKING UTILIZING N-HETEROCYCLIC COMPOUNDS WITH CLEAVABLE OXY SUBSTITUENTS. Jenkins, P. W.; Heseltine, D. W.; Mee, J. D. (to Eastman Kodak Co.). U. S. Patent 3,699,025. 17 Oct 1972. Filed 18 Mar 1971.

Energy-sensitive compounds containing a heterocyclic nitrogen atom substituted with an –OR group are cross-linking agents for polymers having hardenable groups. (Official Gazette)

9372 CONCENTRATION EFFECTS ON PRIMARY PROCESSES IN THE RADIATION CHEMISTRY OF AQUEOUS SOLUTIONS. Peled, E.; Meisel, D.; Czapski, G. (Hebrew Univ., Jerusalem). J. Phys. Chem.; 76: No. 25, 3677-82(7 Dec 1972).

The effect of halides on $G(e^-_{aq})$ and G(OH) was studied by pulse radiolysis. Nearly no increase was found, neither in $G(e^-_{aq})$ nor in G(OH), on increasing the halide concentration (up to 2 M chloride). Concentrations of either 1 M Cl^-, Br^-, or I^- had negligible effect on G(H) + $G(H_2)$. $G(H_2)$ was slightly increased at the expense of G(H). The results are discussed in the light of the spur diffusion model and other recent models. It was concluded that chemical competition between the scavengers used here and the annihilation processes cannot play a significant role in the radiation chemistry of aqueous solutions. (auth)

9373 ELECTRONIC ABSORPTION SPECTRA OF EXCESS ELECTRONS IN MOLECULAR AGGREGATES. I. TRAPPED ELECTRONS IN γ-IRRADIATED AMORPHOUS SOLIDS AT 77°K. Shida, T. (Inst. of Physical and Chemical Research, Wako, Japan); Iwata, S.; Watanabe, T. J. Phys. Chem.; 76: No. 25, 3683-91(7 Dec 1972).

Absorption spectra of trapped electrons were recorded for the low temperature matrices of over 40 different molecules and compared with the theoretical spectra derived from a hydrogenic model for the electron. Remarkable agreement between experiment and theory was obtained for almost all the cases. The analysis of the line shape of the observed spectra in terms of the theory provided information concerning the nature of absorption, the binding energy, and the Bohr radius of the electron in the ground state. Some experimental data of interest appearing in the recent literature were also analyzed by the present theory to obtain successful explanations of the observed spectral features. (auth)

9374 ELECTRONIC ABSORPTION SPECTRA OF EXCESS ELECTRONS IN MOLECULAR AGGREGATES. II. SOLVATED ELECTRONS. Shida, T. (Inst. of Physical and Chemical Research, Wako, Japan); Iwata, S.; Watanabe, T. J. Phys. Chem.; 76: No. 25, 3691-4(7 Dec 1972).

Spectra of solvated electrons from various sources were compiled for analysis in terms of the theory proposed in the preceding paper. The observed absorption line shape was well reproduced by the theoretical simulation spectrum. In particular, the temperature and the pressure effects on the spectrum of hydrated electrons are reasonably accounted for. (auth)

9375 γ-RAY IRRADIATED SODIUM CHLORIDE AS A SOURCE OF HYDRATED ELECTRONS. Gopinathan, C.; Damle, P. S.; Hart, E. J. (Argonne National Lab., IL). J. Phys. Chem.; 76: No. 25, 3694-8(7 Dec 1972).

Hydrated electrons form when γ-ray irradiated sodium chloride dissolves in water. By dissolving the salt in aqueous solutions with different N_2O and O_2 concentrations, N_2 evolves in amounts expected for e^-_{aq}. Below 0.0004 M O_2 the ratio of rate constants, $k[e^-_{aq} + O_2]/k[e^-_{aq} + N_2O]$, of 2.3 ± 0.1 is found for dissolving irradiated NaCl compound with a ratio of 2.4 ± 0.1 in electron or γ-ray irradiated solutions. At higher O_2 concentrations, O_2 is a more effective scavenger of the precursor of e^-_{aq} and the rate constant ratio for this species reaches 14.8. In O_2-free solutions, the N_2 yield is independent of the N_2O concentration in the range 0.0003–0.010 M N_2O and approximates the F center yield. The mechanism of e^-_{aq} formation in dissolving irradiated NaCl is briefly discussed. (auth)

9376 FLUORESCENCE OF THE URANYL ION IN ELECTRON-IRRADIATED SULFURIC ACID SOLUTIONS. Gopinathan, C.; Stevens, G.; Hart, E. J. (Argonne National Lab., IL). J. Phys. Chem.; 76: No. 25, 3698-3702(7 Dec 1972).

The characteristic fluorescence of the UO_2^{2+} ion is obtained in sulfuric acid solutions by irradiation with 6.3 MeV electrons and by tritium β rays from ^3HOH. The effect of UO_2^{2+} concentration in the range from 0.007 to 0.50 M UO_2SO_4 in 0.9 M sulfuric acid is reported. Although Cherenkov light emission may contribute to the fluorescence, it is not the primary source of excitation. Energy transfer from water to the UO_2^{2+} ion and excitation by water subexcitation electrons are briefly discussed as possible mechanisms. (auth)

9377 PULSE RADIOLYSIS OF THE AQUEOUS FERRO-FERRICYANIDE SYSTEM. I. THE REACTIONS OF OH, HO_2, AND O_2^- RADICALS. Zehavi, D.; Rabani, J. (Hebrew Univ., Jerusalem). J. Phys. Chem.; 76: No. 25, 3703-9(7 Dec 1972).

Pulse radiolysis of ferro- and ferricyanide aqueous solutions is investigated at various H^+ and salt concentrations. It was found that association and ion pair formation may affect the reactivity toward OH, HO_2, and O_2^- radicals. The following reaction rate constants were determined (in units of M^{-1} sec^{-1}): $k((OH + Fe(CN)_6^{4-})) = (1.25 \pm 0.1) \times 10^{10}$; $k((OH + HFe(CN)_6^{3-})) = (9.0 \pm 0.9) \times 10^9$; $k((OH + H_2Fe(CN)_6^{2-})) = (1.7 \pm 0.5) \times 10^9$; $k((HO_2 + Fe(CN)_6^{4-})) = (3.0 \pm 1.5) \times 10^4$; $k((HO_2 + HFe(CN)_6^{3-})) = (1.4 \pm 0.1) \times 10^5$; $k((HO_2 + H_2Fe(CN)_6^{2-})) = (1.0 \pm 0.3) \times 10^4$; $k((HO_2 + KFe(CN)_6^{3-})) = (3.0 \pm 1.5) \times 10^4$; $k((O_2^- + Fe(CN)_6^{3-})) = (2.7 \pm 0.9) \times 10^2$; $k((O_2^- + KFe(CN)_6^{2-})) = (6.2 \pm 0.6) \times 10^3$. The last two values are calculated for zero ionic strength. The formation of ion pairs has only a little effect (~10% decrease) on the reactivity of ferrocyanide toward OH radicals. (auth)

9378 EMISSION FROM AROMATIC RADICALS IN ION RECOMBINATION LUMINESCENCE. Brocklehurst, B.; Robinson, J. S.; Tawn, D. N. (Univ. of Sheffield, Eng.). J. Phys. Chem.; 76: No. 25, 3710-13(7 Dec 1972).

Thermoluminescence occurs when solutions of aromatic hydrocarbons are irradiated with γ rays or ultraviolet light and then allowed to warm up, releasing trapped ions. The luminescence spectra consist of emissions from the solute molecules and from related radicals, e.g., benzyl from toluene: loss or gain of a hydrogen atom may occur. Carbanions are likely precursors of the

excited radicals since infrared stimulated emission comes from the molecules, not the radicals, in most cases. At high doses, ground state radicals are formed and then trap charge in a second radiation-dependent step. Surprisingly, radical emission is sometimes observed at low doses (down to 1.5 krads): possible mechanisms are discussed. (auth)

9379 STABILIZED CLUSTER. A MOLECULAR MODEL FOR THE SOLVATED ELECTRON. Howat, G.; Webster, B. C. (Univ. of Glasgow). J. Phys. Chem.; 76: No. 25, 3714-21(7 Dec 1972).

A model is proposed for solvated species generated radiolytically. A cluster of molecules, transiently stabilized, dresses the electron and sustains it until solvation is completed. Calculations are presented within the INDO molecular orbital approximation. The formation and stability of some dimer and tetramer clusters, comprised of water and ammonia molecules, are examined. Spectral properties are determined together with ESR line widths. Dilation phenomena are interpreted. (auth)

9380 APPLICATION OF CHARGE SCAVENGING KINETICS TO THE FORMATION OF EXCITED STATES IN IRRADIATED SOLUTIONS OF AROMATICS IN CYCLOHEXANE. Rzad, S. J. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 25, 3722-9(7 Dec 1972).

Charge scavenging kinetics established previously to account for the time dependence of the biphenylide ion in pulse-irradiated biphenyl–cyclohexane solutions are extended to the formation of excited states in such solutions. It is shown that given a particular reaction scheme the concentration dependence of the excited states in the steady-state radiolysis as well as their time dependence in pulse radiolysis can be described. From the comparison of the predicted behavior and the experimental data available from the literature it is concluded that the triplets and singlets originate predominantly in the three different recombination processes: $S^+ + e$, $S^- + RH^+$, and $S^- + S^+$. Moreover λ, the constant characterizing the ion recombination processes in the pure solvent, can be interpreted to be $\sim 2 \times 10^{11}$ sec^{-1} which indicates that half of the original ions recombine in ~3 psec. This in turn indicates that the rate constant for electron scavenging by biphenyl in cyclohexane is $\sim 3 \times 10^{12}$ M^{-1} sec^{-1}. Implications of these constants are discussed. (auth)

9381 INTERMEDIATE PHASE STUDIES FOR UNDERSTANDING RADIATION INTERACTION WITH CONDENSED MEDIA. THE ELECTRON ATTACHMENT PROCESS. Christophorou, L. G. (Oak Ridge National Lab., TN). J. Phys. Chem.; 76: No. 25, 3730-4(7 Dec 1972).

Current efforts to bridge the gap in our existing knowledge on electron attachment processes in gases and liquids are discussed. The conclusions of a comprehensive study where gaseous data on electron attachment were related to hydrated electron–molecule reaction rates are outlined. The first information on electron attachment to molecules in very high pressure gases is presented, with reference to electron attachment to molecular oxygen to form O_2^- in the presence of increasing pressures of N_2 (0.5 to 15 atm). A model is proposed to account for the latter results. (auth)

9382 RADIATION CHEMISTRY OF CF_4–CCl_4 MIXTURES IN THE GAS PHASE. Marcotte, R. E.; Hanrahan, R. J. (Univ. of Florida, Gainesville). J. Phys. Chem.; 76: No. 25, 3734-41 (7 Dec 1972).

A study was made of the gas-phase γ radiolysis of CF_4–CCl_4 mixtures at 88°C and a total pressure of 920 Torr. Effects of mixture composition, total dose, and added O_2 scavenger on the product yields were measured. The main products in this system are the three possible chlorofluoromethanes. Their yields all maximize in mixtures in which about 90% of the absorbed energy is deposited initially in CF_4; the values found are $G(CF_3Cl) = 2.13$, $G(CF_2Cl_2) = 0.62$, and $G(CFCl_3) = 6.9$. Other significant products are C_2Cl_6 and C_2Cl_4; their yields fall rather smoothly from maximum values of 0.38 and 0.24, respectively, as CF_4 is added to CCl_4. Typical yields of minor products in equimolar mixtures are as follows: C_2F_6, 0.006; $C_2F_3Cl_3$, 0.0003; $C_2F_4Cl_2$, 0.001; C_2F_5Cl, 0.003; Cl_2, 0.03. Since small amounts of added O_2 scavenge between 90 and 100% of all significant products in equimolar mixtures of CF_4 and CCl_4, it appears that the final products result almost completely from free-radical processes under these conditions. At the condition of maximum yield, however, O_2 scavenging is only about 70% effective, and a substantial contribution of ionic processes to final product yields is suggested. (auth)

9383 DEALKYLATION OF ISOPROPYLBENZENE ON γ-IRRADIATED SILICA–ALUMINA. THE EFFECT OF VARIOUS REAGENTS ON THE ACTIVE CENTERS AND ON THEIR YIELD. Rojo, E. A.; Hentz, R. R. (Comision Nacional de Energia Atomica, Buenos Aires). J. Phys. Chem.; 76: No. 25, 3741-4(7 Dec 1972).

A silica–alumina gel was exposed to a gaseous reagent during or after γ irradiation, and the yield of benzene (molecules formed per gram of solid) on subsequent exposure to isopropylbenzene was determined. The following reagents were used: N_2, H_2, O_2, CO_2, N_2O, C_2H_4, NH_3, H_2S, CO, and SO_2. In general, effects of the reagents on the benzene yield correlate with previously reported effects of the same reagents (for corresponding conditions) on the positive-hole ESR spectrum of the irradiated silica–alumina. The ESR spectrum includes contributions from a positive hole trapped on a bridging oxygen atom bonded to a substitutional Al atom and from certain positive holes trapped on nonbridging oxygen. Certain of the results indicate that the yield of benzene from contact of isopropylbenzene with silica–alumina irradiated alone, like the yield of trapped positive holes seen in the ESR spectrum, is limited by the number of preexisting electron traps in the silica–alumina matrix. The total results seem to require that electron transfer from isopropylbenzene to a trapped positive hole (of any kind contributing to the ESR spectrum) be the primary process in isopropylbenzene dealkylation on γ-irradiated silica–alumina. (auth)

9384 ELECTRONIC SPECTRA OF TRAPPED ELECTRONS IN ORGANIC GLASSES AT 4°K. III. EFFECT OF AN ELECTRON SCAVENGER IN ETHANOL. Higashimura, T.; Namiki, A.; Noda, M.; Hase, H. (Kyoto Univ., Osaka). J. Phys. Chem.; 76: No. 25, 3744-6(7 Dec 1972).

Optical absorption measurements were carried out on $e_{\tilde{}}^-$ and $e_{\tilde{}col}^-$ in ethanol glasses containing solute BzCl at 4 and 77°K. The electron scavenging efficiency for the γ radiolysis at 4°K is about 4 times larger than for the radiolysis at 77°K and depends slightly on the wavelength of the absorption band. The temperature dependence of the efficiency is tentatively attributed to that of the scavenging cross section obeying the $1/v$ law and/or to that of trapping cross section affected by lattice phonon interaction. (auth)

9385 DISSOCIATIVE ELECTRON ATTACHMENT TO DIMETHYL ETHER IN IRRADIATED 3-METHYLPENTANE GLASS. Yoshida, H.; Irie, M.; Shimada, O.; Hayashi, K. (Hokkaido Univ., Sapporo). J. Phys. Chem.; 76: No. 25, 3747-50(7 Dec 1972).

The trapped electron in γ-irradiated 3-methylpentane glass containing dimethyl ether shows an ESR spectrum of 3.7 G width and an optical absorption band with a maximum at 1250 nm. It is bleached with light of a wavelength shorter than 1170 nm. The photobleaching is followed by the formation of methyl radical. The conversion efficiency from a trapped electron to a methyl radical is found to be independent of the wavelength in the range examined (1170 to 600 nm). All experimental results indicated that the methyl radical is formed by dissociative electron attachment to dimethyl ether which occurs only when the trapped electron is photobleached but does not occur during γ irradiation. According to gas-phase data, the reaction is expected to be endothermic by about 0.7 eV, although this value may be decreased somewhat in the glassy matrix. Therefore, the results seem to lead to the amazing conclusion that all electrons detrapped by light have an appreciable amount of kinetic energy independent of the photon energy of the light. (auth)

9386 KINETICS OF DEFECT AND RADIOLYTIC PRODUCT FORMATION IN SINGLE CRYSTAL SODIUM BROMATE DETERMINED FROM COLOR-CENTER MEASUREMENTS. Levy, P. W. (Brookhaven National Lab., Upton, NY); Goldberg, M.; Herley, P. J. J. Phys. Chem.; 76: No. 25, 3751-8(7 Dec 1972).

The kinetics of defect and/or radiolysis product formation in single crystal $NaBrO_3$ were studied using color-center, i.e., optical absorption, techniques. Samples were exposed to x-rays, γ-rays, or ultraviolet light at liquid helium, liquid nitrogen, and room temperatures. The radiation-induced absorption depends on the irradiation temperatures and the type of radiation used. The observed spectra can be resolved into six prominent and one, two, or three weak Gaussian-shaped absorption bands. Some of these bands are described in the literature and appear to be correlated with specific radiolysis products. The various observed growth curves can be grouped into distinct categories broadly characterized as linear which is possibly a special case of a saturating exponential, linear plus saturating exponential, concave, and sigmoid. Expressions for these curves can be derived from very simple kinetic models involving defect, i.e., precursor, formation and subsequent charge transfer. The experimentally determined curves are accurately described by these expressions. (auth)

9387 APPLICATION OF ELECTRON CYCLOTRON RESONANCE TECHNIQUE IN STUDIES OF ELECTRON CAPTURE PROCESSES IN THE THERMAL ENERGY RANGE. Mothes, K. G.; Schultes, E.; Schindler, R. N. (Kernforschungsanlage, Juelich, Ger.). J. Phys. Chem.; 76: No. 25, 3758-64(7 Dec 1972).

A method is described by which absolute cross sections can be determined for the capture of thermal electrons in the gas phase.

Also the energy dependence for the attachment process can be followed in the energy range of 1 to 10kT. The method is based on electron cyclotron resonance (ecr) measurements of photochemically produced electrons in a fast-flow system. A short account is given of the physical background of the ecr technique. The thermalization of the electrons and the influence of pressure and power on the signal parameters are discussed. Absolute rate constants for the attachment of thermal electrons are reported for the following groups of molecules: (a) very effective electron scavengers, CCl_4, SF_6, C_4F_8, and C_7F_{16}; (b) the CN containing compounds, ICN, ClCN, BrCN, CNCN, HCN, CH_3CN, and C_2H_3CN; and (c) the molecules NF_3, N_2F_4, CF_2Cl_2, $C_2F_4Cl_2$, HBr, and CH_3Br. Electron affinities for SF_6 and C_4F_8 were calculated with the absolute values of the thermal rate constants. Three typical examples for the energy dependence of the cross section are given. (auth)

9388 SOLVATED ELECTRONS IN IRRADIATED CONCENTRATED ALKALINE METHANOL AND WATER–METHANOL MIXTURES. Pikaev, A. K.; Zhestkova, T. P.; Sibirskaya, G. K. (Inst. of Physical Chemistry, Moscow). J. Phys. Chem.; 76: No. 25, 3765-71(7 Dec 1972).

The properties of solvated electrons (e_s^-) in concentrated alkaline methanol and water–methanol mixtures with emphasis on their optical absorption spectra, decay kinetics, and yields were studied by the pulse radiolysis method. In methanol at $[CH_3ONa] \geq 3.5$ M a maximum (λ_{max}) of e_s^- optical band is shifted slightly to the shorter wavelengths. In alkaline water–methanol mixtures λ_{max} has an intermediate position between pure alkaline methanol and water. In some cases the optical band of e_s^- also has a shoulder at longer wavelengths, which seems to belong to a particle of the type $Me^+ \ldots e_s^-$. The e_s^- decay in alkaline methanol occurs in a reaction of pseudo-first order; in water–methanol mixtures the kinetics of this process is complex. The rate constants $k(H + CH_3O^-)$ in alkaline methanol and $2k(e_s^- + e_s^-)$ in water–methanol mixtures were evaluated. The first rate constant is equal to $\sim 1.2 \times 10^7$ M^{-1} sec^{-1}; the second is dependent on water content in the mixture, increasing from $\leq 10^9$ M^{-1} sec^{-1} for 5.5 M methanolic solution of CH_3ONa to $\sim(3\text{–}4) \times 10^9$ M^{-1} for 6 M aqueous solution of NaOH. The values of $G(e_s^-)\epsilon_{max}$ (ϵ_{max} is molar extinction coefficient of e_s^- at λ_{max}) were measured. It has been estimated that in alkaline methanol ϵ_{max} is equal to 9.7×10^3 M^{-1} cm^{-1}. It is increased with the growth of water content in the mixture, reaching 1.6×10^4 M^{-1} cm^{-1} for 6 M aqueous solution of NaOH. (auth)

9389 EXCITONS BOUND TO IONIZED IMPURITIES IN INORGANIC CRYSTALS. Elkomoss, S. G. (Institut de Physique, Strasbourg). J. Phys. Chem.; 76: No. 25, 3771-6(7 Dec 1972).

Pekeris' method for helium atom generalized recently by Frost for the three-particle systems was developed extensively to apply to excitons bound to ionized impurities in inorganic crystals. Haken's exciton potential, where the dielectric constant between the two particles is a function of the interparticle distance, the optical and static dielectric constants, the electron and hole effective masses m_e^* and m_h^*, respectively, and the longitudinal vibrational frequency of the lattice, has been generalized for the three particles. This potential shows the important effect of the polarizability. A considerably long recursion relation of 57 terms has been derived. In exciton-ionized-donor complexes, the binding energy of the system is a function of the mass ratio m_e^*/m_h^*. This complex was studied for real systems such as CdS, ZnO, CuCl, CuBr, CuI, ZnSe, ZnTe, CdTe, SiC 6H, TlCl, and TlBr. The agreement with experiment is better than that obtained previously where the polarizability has been neglected. The calculations were also carried out for exciton–ionized acceptor. In this case the results are given in terms of the mass ratio m_h^*/m_e^*. For known inorganic crystals, the mass ratio is usually high, and consequently it is highly improbable to find such a stable complex for these crystals. (auth)

9390 POLARON YIELDS IN LOW-TEMPERATURE PULSE RADIOLYSIS OF CHEMICALLY INERT AQUEOUS MATRICES. Shubin, V. N.; Sharanin, Yu. I.; Pernikova, T. E.; Vinogradov, G. A. (Inst. of Electrochemistry, Moscow). J. Phys. Chem.; 76: No. 25, 3776-9(7 Dec 1972).

The competition between the recombination of activated electrons with parent positive ions and the formation of localized electrons (polarons) is considered. The equation obtained as the result of a physico-mathematical analysis gives a satisfactory explanation of the dependence of the polaron yield on temperature, experimentally observed in crystalline ice. The calculated value of the activation energy is equal to 0.12 eV, which suggests the localization process has an energy threshold. The possibility of polaron formation as a result of dissociation of an excited state in alkaline glasses is postulated. This can be the reason for the anomalous dependence of $G(e_s^-)$ on temperature in 10 M alkaline solutions. Energetic characteristics of the water excited state were estimated. The calculated excitation potential is equal to 9.3 eV. (auth)

9391 CHERENKOV REABSORPTION SPECTROSCOPY FOR SUBNANOSECOND PULSE RADIOLYSIS STUDIES. Wallace, S. C.; Walker, D. C. (Univ. of British Columbia, Vancouver). J. Phys. Chem.; 76: No. 25, 3780-93(7 Dec 1972).

Cherenkov reabsorption spectroscopy involves the measurement of absorption by radiation produced species of the system's own Cherenkov light when subjected to a pulse of high energy electrons. Absorption spectra are obtained as the difference between the partially reabsorbed Cherenkov spectrum and the true Cherenkov emission spectrum. The enormous dose rate provided by the 3-nsec pulse of 600-kV electrons from a Febetron accelerator provides very considerable sensitivity, enabling, for instance, the absorption spectrum of the hydrated electron to be observed in 3 M $HClO_4$ solutions where the mean lifetime of e_{aq}^- is only $\sim 3 \times 10^{-11}$ sec. Thus while utilizing comparatively simple spectrographic or nanosecond spectrophotometric detection systems, the picosecond events of radiolysis may be examined. Several experimental methods and the theoretical treatment of the data are presented in detail. The measured absorption is shown to be related to the product $G\epsilon\tau$ for the absorbing species in different ways depending on the experimental conditions. Results are given which demonstrate the potentialities of the method and corroborate some of the important results obtained by Hunt, et al., on the picosecond time scale for water. These include the measurement of a primary yield of e_{aq}^- of 3.2 ± 0.8 for the pH range 0–7, presolvation scavenging by solutes except H^+, the absorption spectrum in the presence of molar concentrations of scavengers, lack of evidence for time-dependent pseudo-first-order rate constants at ~1 M concentration, and relative yields of solvated electrons in aliphatic alcohols. (auth)

9392 RANGES OF PHOTOINJECTED ELECTRONS IN DIELECTRIC LIQUIDS. Holroyd, R. A.; Dietrich, B. K.; Schwarz, H. A. (Brookhaven National Lab., Upton, NY). J. Phys. Chem.; 76: No. 25, 3794-3800(7 Dec 1972).

Measurements of the current efficiency of liquid-filled phototubes are used to determine the ranges of low-energy (0.1 to 0.5 eV) electrons in liquids. The efficiency depends on the applied field as well as on the nature of the liquid but is not affected by low concentrations of electron trapping solutes. Certain liquids such as neopentane and tetramethylsilane yield currents comparable to the vacuum current at an electric field of 10^4 V/cm, whereas n-hexane and n-pentane yield currents a few orders of magnitude less. The differences in current for various liquids are attributed to the differences in thermalization ranges of the photoinjected electrons. The model used to analyze the results assumes that the injected charges diffuse subject to the concentration and potential gradients, where the potential is the sum of the applied and image potentials. This model successfully accounts for the observed voltage dependence of the currents and shows that low-energy electrons penetrate considerable distances into the liquids and thermalize without significant back scattering. The observed values of b for a Gaussian distribution of ranges are: for n-pentane, 36 Å; cyclopentane, 77 Å; neopentane, 147 Å; n-hexane, 42 Å; 2-methylpentane, 58 Å; 3-methylpentane, 50 Å; 2,2,4-trimethylpentane, 102 Å; and tetramethylsilane, 177 Å. These values are comparable to the ranges of the more energetic electrons formed in X-irradiated liquids and demonstrate that most of the range of such electrons is attained at epithermal energies. (auth)

9393 TRIPLET FORMATION IN ION RECOMBINATION IN SPURS. Magee, J. L.; Huang, J. T. J. (Univ. of Notre Dame, IN). J. Phys. Chem.; 76: No. 25, 3801-5(7 Dec 1972). (COO-38-824).

It is generally believed that ion recombination is an important mechanism for production of excited states in irradiated systems. In many such systems the recombination occurs within spurs and takes place before spin relaxation. Under such conditions the probability for triplet formation is a simple combinatorial problem and yields the result, $P_T = (3/4)[1 - 1/(2n - 1)]$, where n is the number of ion pairs in the spur. The direct impact excitation of triplet states in spurs alters this result. The general problem of ion recombination in spurs which also contain triplet molecules excited by subexcitation electrons is discussed and general formulas are presented. The average over spur size distribution and comparison with experiment are discussed. (auth)

9394 EXCITED STATES IN THE NANOSECOND PULSE RADIOLYSIS AND LASER FLASH PHOTOLYSIS OF N,N-DIMETHYLANILINE. Land, E. J.; Richards, J. T.; Thomas, J. K. (Argonne National Lab., IL). J. Phys. Chem.; 76: No. 25, 3805-12(7 Dec 1972).

Nanosecond pulse radiolysis and laser flash photolysis of dimethylaniline (DMA) and its solutions lead to the observation of excited states rather than ions. Both techniques were used to characterize the absorptions of singlet excited DMA, triplet excited DMA, and the DMA exciplexes of anthracene, 1,2-benzanthracene,

biphenyl, naphthalene, and pyrene. After such exciplexes had decayed the hydrocarbon triplet absorptions alone remained. Singlet excited DMA ($t_{\frac{1}{2}} \sim 3$ nsec) absorbs in the infrared and is monomeric. Triplet excited DMA ($t_{\frac{1}{2}} = 250$ nsec in pure DMA) absorbs at 465 nm, ϵ 5000 M^{-1} cm^{-1}. The triplet half-life increases when the DMA is dissolved in benzene or cyclohexane. The singlet→triplet crossover efficiency of DMA was estimated to be 0.95. The primary yields of triplet and singlet excited DMA on radiolysis were estimated to be 3.1 and 0.9, respectively. The absorption spectra, extinction coefficients, singlet→triplet crossover efficiencies, rates of formation, and rates of decay of the DMA–aromatic hydrocarbon exciplexes were estimated. Studies of the system anthracene plus DMA in cyclohexane show a "grow-in" of anthracene triplet at a rate equal to the DMA–anthracene exciplex decay rate. Thus, contrary to the conclusions of previous workers, such exciplexes do appear to fit into the normal pattern of the aromatic hydrocarbon triplet originating from the thermalized fluorescent state, in this case of the exciplex. (auth)

9395 LIFETIME DISTRIBUTION FUNCTION FOR GEMINATE ION PAIRS AND ITS IMPORTANCE TO THE KINETICS OF IONIC REACTIONS IN THE RADIOLYSIS OF HYDROCARBON SOLUTIONS. Schuler, R. H.; Infelta, P. P. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 25, 3812-23(7 Dec 1972).

The concentration dependence for the reaction between ions produced in the radiolysis of hydrocarbons and solutes added to scavenge these ions can be related to the Laplace transform of the distribution of lifetimes of the ion pairs in the pure hydrocarbon. It is shown that this Laplace transform provides a phenomenological model which allows the derivation of the concentration dependence of secondary ionic reactions in a quite general way, even without an explicit expression for the lifetime distribution function. It is also shown that given an appropriate reaction scheme certain limitations are placed on the importance of secondary reactions as a natural result of the short lifetime of most of the ion pairs. Measurements on electron scavenging by the alkyl halides have given an algebraic expression which appears to represent the concentration dependence for the scavenging process quite accurately. Use of this expression allows one to make quantitative predictions from the above mentioned relationships. A number of examples have already been considered and are summarized. Two new examples are treated here: the effect of electron scavengers on the HD yields from ND_3 solutions and the production of H_2 and I_2 from HI solutions. An explicit description for the distribution of ion pair lifetimes can be derived by taking the inverse Laplace transform of the observed scavenging dependence. Some general comments are made on the characteristics and consequences of this description as it applies to the direct observation of intermediates in pulse experiments. (auth)

9396 FORMATION OF SOLVATED ELECTRONS IN DILUTE SOLUTIONS OF POLAR MOLECULES IN NONPOLAR SOLVENTS. Mozumder, A. (Univ. of Notre Dame, IN). J. Phys. Chem.; 76: No. 25, 3824-9(7 Dec 1972). (COO-38-844).

A theoretical model is presented for the time required to form solvated electrons in a dilute solution of polar molecules in a nonpolar solvent when irradiated by ionizing radiation. The polar molecules are assumed to exist as monomers; however, this assumption is not seen as a serious limitation to the applicability of the model. In the system considered an electron escaping geminate neutralization following an ionization event will eventually find itself attached to a polar molecule, which is the first step in the formation of the solvated electron. This process is always very fast. In the second step neighboring dipoles coagulate to the central negative charge. This process is relatively slow, consisting of dipole rotation and drift which contribute comparably to the so-defined microscopic relaxation time. The analysis presented here describes motions of electrons and dipoles in terms of drift velocities. The latter are obtained from instantaneous electric fields and linear and rotational mobilities. Concentration dependence of solvated electron formation time is evaluated and comparison with experiments is indicated. (auth)

9397 ENERGY LEVEL STRUCTURE AND MOBILITIES OF EXCESS ELECTRONS IN AQUEOUS AND ORGANIC GLASSES. Kevan, L. (Wayne State Univ., Detroit). J. Phys. Chem.; 76: No. 25, 3830-8(7 Dec 1972).

Recent photoconductivity and optical bleaching studies of trapped electrons (e_t^-) as a function of wavelength and temperature have delineated the energy level structure of electrons in matrices of varying polarity. Results are described for alkaline ice (10 M NaOH), 5 M K_2CO_3 ice, crystalline ice, methyltetrahydrofuran (MTHF), and 3-methylhexane (3MH) solid matrices. In alkaline ice no stable bound excited state exists for trapped electrons. This conclusion is based on a wavelength-independent quantum efficiency for bleaching in the e_t^- absorption band and on temperature-independent photoconductivity and optical bleaching responses between 77 and 4.2°K. In single crystal ice an excited state for e_t^- is found ~0.4 eV below the lowest conduction level from photobleaching quantum efficiency measurements. In MTHF two excited states of e_t^- have been found. One is optically allowed and is ~0.6 eV below the bottom of the conduction state in a vertical transition from the ground state. The other is optically forbidden and is ~1.1 eV below the bottom of the conduction state in a vertical transition from this optically forbidden state. If the ground state is described by a 1s type wave function, the optically allowed state can be described by a 2p function and the optically forbidden state by a 2s function. Photoconductivity can be generated by both one- and two-photon processes. The two-photon process can be interpreted to occur via a 2s state. The energy level structure of e_t^- in 3MH is similar to that in MTHF. The energy level structure in the different matrices can be semiquantitatively accounted for by the semicontinuum model for trapped electrons. Both Hall and drift mobilities have been measured for photoexcited electrons in alkaline ice. The results are well described by a band model and the main scattering mechanisms are identified as optical lattice phonon scattering and O^- Coulombic scattering. Drift mobilities of mobile electrons in MTHF indicate that the electron motion is best described by a hopping model from 40 to 77°K. (auth)

9398 INVESTIGATION OF THE STRUCTURE OF THE HYDRATED ELECTRON BASED ON UNPAIRED ELECTRON DENSITIES CALCULATED BY THE INDO METHOD. Kerr, C. M. L.; Williams, F. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Phys. Chem.; 76: No. 25, 3838-42 (7 Dec 1972). (ORO-2968-75).

Spin density distributions were calculated for a number of possible structures for the hydrated electron, and the total spin density associated with the hydrogen atoms compared with the value derived from ESR experiments. Although the agreement with experiment is not close, the best results are obtained for a planar dimeric structure containing two central hydrogens close to one another. The structure of the hydrated electron may incorporate symmetrically placed units of this type. (auth)

9399 PRECISE MEASUREMENTS OF W, THE AVERAGE ENERGY REQUIRED FOR ION PAIR FORMATION. II. ALCOHOLS AND WATER. Meisels, G. G.; Ethridge, D. R. (Univ. of Houston, TX). J. Phys. Chem.; 76: No. 25, 3842-6(7 Dec 1972).

Ionization currents produced in simple alcohols by the decay of ^{63}Ni were measured with a reproducibility of about 0.01% at approximately 100 and 200°C and over a pressure range of from 600 to 2500 Torr. In methanol and ethanol extrapolated and normalized ionization currents appear to decrease by approximately 5% over this range; this is ascribed to incomplete ion collection by applying a criterion for the attainment of saturation based on an analysis of slopes of current vs. potential curves. The following values of W relative to $W(N_2) = 34.6$ were obtained in the lower pressure range where ion collection is essentially complete: $W(H_2O) = 29.15 \pm 0.09$, $W(CH_3OH) = 25.02 \pm 0.09$, $W(C_2H_5OH) = 24.50 \pm 0.09$, $W(n\text{-}C_3H_7OH) = 23.86 \pm 0.08$, $W(i\text{-}C_3H_7OH) = 24.25 \pm 0.09$, $W(n\text{-}C_4H_9OH) = 23.53 \pm 0.12$, $W(2\text{-}C_4H_9OH) = 23.53 \pm 0.12$, and $W(i\text{-}C_4H_9OH) = 23.38 \pm 0.11$ eV per ion pair. (auth)

9400 SPECTRAL SHIFTS OF TRAPPED ELECTRONS IN ALKANE GLASSES AT 76°K. Klassen, N. V.; Gillis, H. A.; Teather, G. G. (National Research Council of Canada, Ottawa). J. Phys. Chem.; 76: No. 25, 3847-50(7 Dec 1972).

The spectra of the trapped electron in 3-methylpentane and 3-methylhexane glasses at 76°K as determined by pulse radiolysis were found to shift toward the blue on a time scale of mseconds, seconds, and minutes. For 3-methylhexane λ_{max} is approximately 2000 and 1700 nm at 3 μsec and 380 sec, respectively. For 3-methylpentane λ_{max} is approximately 1900 at 10 μsec and shifts to about 1700 nm at 380 sec. The spectra at 380 sec are very similar to those determined by others after ^{60}Co irradiation. Geminate recombination occurs simultaneously with the spectral shifts, but an experiment with added biphenyl indicates that the mechanism involved in the spectral shifts is predominantly molecular reorientation rather than detrapping-retrapping. (auth)

9401 EFFECT OF TEMPERATURE IN THE RADIOLYSIS OF PARAFFINS. Gaeumann, T.; Rappoport, S.; Ruf, A. (Federal School of Tech., Lausanne, Switzerland). J. Phys. Chem.; 76: No. 25, 3851-5(7 Dec 1972).

The radiolysis of n-paraffins with 5 to 16 carbon atoms is reviewed. The G values of the products, excepting dimers, are approximately the same for all the above paraffins. The temperature dependence is expressed as an apparent activation energy. The material balance shows that the product analysis is not complete and that the missing substances have a molecular weight higher than that of the dimers. The hydrogen production is divided

into three processes: unimolecular hydrogen production, abstraction by thermal atoms, and abstraction by "hot" hydrogen atoms. (auth)

9402 PICOSECOND OBSERVATIONS OF SOME IONIC AND EXCITED-STATE PROCESSES IN LIQUIDS. Beck, G.; Thomas, J. K. (Univ. of Notre Dame, IN). J. Phys. Chem.; 76: No. 25, 3856-63(7 Dec 1972). (COO-38-846).

The design of a pulse radiolysis system for absorption and emission spectroscopy with a response down to 60 psec is described. Events which occur with response times of about 10 psec may also be observed by observing the development of these species during the radiation pulse. The system has been used to investigate the mode of formation of solute excited states in cyclohexane, the benzene excimer in pure benzene, and the rate of formation of solvated electrons in ethanol and 1-propanol. The data show that the excited singlet state of cyclohexane is formed rapidly (<10 psec) in radiolysis, and has a decay constant of 3.6×10^9 sec^{-1}. The state transfers energy to added solutes such as benzene, with $k = 2.2 \times 10^{11}$ M^{-1} sec^{-1}; CCl_4, $k = 2.5 \times 10^{11}$ M^{-1} sec^{-1}; and 9,10-diphenylanthracene, $k = 3.4 \times 10^{11}$ M^{-1} sec^{-1}. No significant yield of the triplet state of the aromatic solutes is observed in pseconds contrary to the large yields of triplets observed in nseconds. The anions and cations of the aromatic solutes are also observed, and exhibit rapid formation but little decay in pseconds. The excimer state of benzene is observed to appear with a delay of 10 psec, and this is considered to be the result of prior formation of the monomer singlet followed by the complexing time which is calculated to be 7 psec. The solvated electron in ethanol is formed rapidly but with a possible delay of 2 to 5 psec, while the solvated electron in 1-propanol is formed over 50 psec. The data are discussed in terms of current theories of radiation chemistry. (auth)

9403 RADIOLYSIS OF AQUEOUS METHANE SOLUTIONS. Stevens, G. C.; Clarke, R. M.; Hart, E. J. (Argonne National Lab., IL). J. Phys. Chem.; 76: No. 25, 3863-7(7 Dec 1972).

The γ-ray and electron pulse irradiation of aqueous methane and some ethane solutions is reported. The absorption spectra of the CH_3 and C_2H_5 free radicals were measured in the wavelength range 210 to 270 nm. At 210 nm $\epsilon(CH_3) = 850$ M^{-1} cm^{-1} and $\epsilon(C_2H_5) = 520$ M^{-1} cm^{-1}. The bimolecular recombination rate constants are $1.24 \times 0.2 \times 10^9$ and $0.96 \pm 0.2 \times 10^9$ M^{-1} sec^{-1} for CH_3 and C_2H_5, respectively. The rate constant $k(OH + CH_4) = 1.21 \pm 0.4 \times 10^8$ M^{-1} sec^{-1}; $k(CH_3 + H_2O_2) = 3.5 \times 10^7$ M^{-1} sec^{-1}. The yields $G(-CH_4)$, $G(C_2H_6)$, $G(H_2)$, $G(H_2O_2)$, and $G(N_2)$ for N_2O-CH_4 solutions are reported for some acid, neutral, and alkaline solutions. A radiolysis mechanism is also given. (auth)

9404 FORMATION OF EXCITED SINGLET STATES IN IRRADIATED AROMATIC LIQUIDS. Fuchs, C.; Heisel, F.; Voltz, R. (Laboratoire de Physique des Rayonnements et d'Electronique Nucleaire, Strasbourg). J. Phys. Chem.; 76: No. 25, 3867-75(7 Dec 1972).

Vacuum ultraviolet excited fluorescence and fast electron excited radioluminescence are used to study the mechanisms of formation of the lowest excited singlet states in liquid benzene and alkylbenzenes. From the measurements of fluorescence excitation spectra, it is concluded that the upper singlet levels in these liquids essentially decay by autoionization when their excitation energy is larger than a characteristic critical value, equal to 7 eV in the case of benzene. Efficient recombination fluorescence indicates that charge separation is followed by geminate recombination, without spin relaxation, from the lowest charge-transfer state to the first excited singlet state of the molecules. The scintillation decay laws and absolute yields, measured under electron irradiation, allow one to distinguish the promptly formed singlet states from those resulting from triplet–triplet annihilation in blobs and short tracks. The "prompt" singlet states are found to be produced with G values near unity; the data are interpreted using the general results obtained with vacuum ultraviolet excitation and taking into account the possible track effects. (auth)

9405 TEMPERATURE SHIFTS IN THE OPTICAL SPECTRA OF SOLVATED ELECTRONS IN METHANOL AND ETHANOL. Jha, K. N.; Bolton, G. L.; Freeman, G. R. (Univ. of Alberta, Edmonton). J. Phys. Chem.; 76: No. 25, 3876-83(7 Dec 1972).

At 295°K the e^-_{solv} absorption peak E_{max} and the width of the band at half height $W_{\frac{1}{2}}$ were respectively 1.95 and 1.3 eV in methanol and 1.80 and 1.4 eV in ethanol. At temperatures between 170 and 350°K, $dE_{max}/dT = -2.6 \times 10^{-3}$ eV/deg in methanol and -3.2×10^{-3} eV/deg in ethanol. Increasing T increased $W_{\frac{1}{2}}$ slightly. The shifts in E_{max} caused by changing the temperature or pressure (up to 6000 atm) in a given liquid (alcohol or water) correlate with the product of the dielectric constant and the density, ϵd. Plots of E_{max} vs. ϵd overlap for methanol and ethanol, but the curve for water falls at higher values of ϵd for a given E_{max}. Electron–solvent short range interactions appear to be important in determining E_{max}. The e^-_{solv} spectra were not changed in shape by addition of up to 1.4 M KOH. The height of the absorption band increased with increasing base concentration due to scavenging of H^-_{solv} in the spurs. The molar absorbancy (decadic) coefficient of e^-_{solv} was independent of temperature: $\epsilon(\lambda_{max})$ $(10.2 \pm 0.4) \times 10^3$ M^{-1} cm^{-1} in methanol, $(9.4 \pm 0.4) \times 10^3$ in ethanol and $(18.9 \pm 0.6) \times 10^3$ in water. The oscillator strength of e^-_{solv}, corrected for the refractive index of the solvent, is 0.4 in methanol and ethanol and 0.6 in water and ammonia. (auth)

9406 HOT ELECTRON INJECTION INTO DENSE METHANE, CARBON MONOXIDE, AND CARBON DIOXIDE. Smejtek, P.; Silver, M. (Univ. of North Carolina, Chapel Hill). J. Phys. Chem.; 76: No. 25, 3890-3(7 Dec 1972).

Injection currents were studied in order to understand the electronic transport properties in liquids and dense gases. In particular tunnel cathodes were used to inject hot electrons into CH_4, CO, and CO_2. The current vs. voltage characteristics were measured for various densities. In order to analyze the data a simple model was used for injection. From this model the cross section can be estimated for momentum exchange scattering and the energy relaxation time of the hot electrons. The density dependence of these parameters and their implication are discussed. (auth)

9407 NEGATIVE SPECIES FORMED IN γ- OR ULTRAVIOLET-IRRADIATED NONPOLAR GLASSES. Truong, T. B.; Bernas, A. (CNRS, Orsay, France). J. Phys. Chem.; 76: No. 25, 3894-7(7 Dec 1972).

As previously shown by several authors, negative species formed in photoionized or γ-irradiated solid solutions can be sensitively characterized by optically stimulating a neutralization luminescence. At least in nonpolar matrices, the neutralization luminescence excitation spectrum closely parallels the negative species absorption spectrum. For N,N,N',N'-tetramethyl-p-phenylenediamine (TMPD) photoionized in 3-methylpentane (3MP) or methylcyclohexane (MCH) and pure γ-irradiated 3MP and MCH, three distinct negative species are thus characterized: (1) the matrix trapped electrons, among which glass relaxation effects permit us to distinguish type a and type b trapped electrons; (2) the TMPD anion, or a negatively charged TMPD photoproduct; and (3) a third species X^- observable only after large uv or γ-ray doses and electron ir bleaching. Since the solute photoionization is accompanied by the solvent sensitized dissociation, the species X^- can very likely be identified with R^-_{solv}, $R\cdot$ deriving from a hydrogen atom abstraction from the solvent molecule. The technique of neutralization luminescence stimulation permits us to differentiate R^-_{solv} from $R\cdot_{solv}$ which have both an optical absorption in the same uv range. (auth)

9408 PULSE RADIOLYSIS OF SOLUTIONS OF STILBENE. I. EVIDENCE FOR TRIPLET AND SINGLET EXCITED STATE FORMATION. Dainton, F.; Robinson, E. A.; Salmon, G. A. (Cookridge Hospital, Leeds, Eng.). J. Phys. Chem.; 76: No. 25, 3897-3904(7 Dec 1972).

The triplet state of trans-stilbene was estimated, both by direct observation and by an energy transfer method, to have a natural first-order decay constant, $k = 1.06 \pm 0.26 \times 10^7$ sec^{-1}, in benzene solution. This species can transfer triplet energy to anthracene with a second-order rate constant, $k = 2.6 \pm 0.5 \times 10^9$ M^{-1} sec^{-1}. Other energy transfer processes involving the cis and trans isomers of stilbene were investigated. (auth)

9409 AB INITIO STUDIES OF THE INTERACTIONS OF AN ELECTRON AND TWO WATER MOLECULES AS A BUILDING BLOCK FOR A MODEL OF THE HYDRATED ELECTRON. Naleway, C. A.; Schwartz, M. E. (Univ. of Notre Dame, IN). J. Phys. Chem.; 76: No. 25, 3905-8(7 Dec 1972). (COO-38-835).

As a first step toward understanding the hydrated electron from a microscopic viewpoint, a simple dimer of H_2O plus an extra electron was studied by the ab initio LCAO–SCF–MO approach with a "double ζ" basis set for numerous geometrical configurations. The energetics of the system show most stability for a configuration with two protons from different H_2O molecules pointing toward one another, much as in the D defects of the Bjerrum model for ice. This gives a natural viewpoint for the discussion of electron trapping. Some indication is given of planned further work using a many water model based on the present studies. (auth)

9410 γ RADIOLYSIS OF XENON TRIOXIDE IN AQUEOUS SOLUTION. Heitz, C.; Haissinsky, M. (Laboratoire Curie, Paris). J. Phys. Chem.; 76: No. 25, 3909-10(7 Dec 1972).

A study was made of the γ radiolysis of aqueous solutions of XeO_3 and the yields of the disappearance of XeO_3 were measured by iodometry. At pH 1.25 the initial G is the same in aerated and argon-saturated solutions. The amount of decomposition increases linearly with dose up to at least 20% decomposition of the solute.

G increases with increase in solute concentrations and with decrease in dose rate. At pH 6 in aerated solutions the initial G is high and increases with increase in solute concentration. With decrease in dose rate to aerated solutions G increases. In solutions saturated with argon at pH 6, G decreases slightly with increase in solute concentration and becomes almost constant at approximately 7.5 for concentrations greater than 10^{-2} M. The $G \approx 7.5$ at high concentrations is independent of the dose rate while G at small concentrations increases with decrease in dose rate. (D.H.M.)

9411 NATURE OF THE SOLID PRODUCTS FROM CO RADIOLYSIS. Baird, T. (Univ. of Glasgow). Carbon; 10: No. 6, 723-8(Dec 1972).

Infrared spectroscopy and other techniques have been used to study the chemical nature of the solids produced by radiolysis of CO both alone and admixed with $Fe(CO)_5$. The difference in the behavior of the resulting solids towards water has been accounted for in terms of the differences observed in the chemical structures of the solids. (auth)

9412 ONE-ELECTRON REDUCTION OF THE DISULFIDE LINKAGE IN AQUEOUS SOLUTION. FORMATION, PROTONATION, AND DECAY KINETICS OF THE $RSSR^-$ RADICAL. Hoffman, M. Z.; Hayon, E. (Army Natick Labs., MA). J. Amer. Chem. Soc.; 94: No. 23, 7950-7(15 Nov 1972).

The rupture of disulfide linkages by the one-electron transfer agents e^-_{aq} and H atoms in aqueous solution was studied using the fast-reaction technique of pulse radiolysis and kinetic absorption spectrophotometry. Dithiodiacetic acid, dithiodipropionic acid, cystine, cystamine, cystine dimethyl ester, penicillamine disulfide, glutathione disulfide, and lipoic acid were investigated. The reaction rate constants of e^-_{aq} with these disulfide compounds (RSSR) were determined and were found to be markedly dependent upon the state of protonation of the amino groups (for the amino acid disulfides), with the rate decreasing on deprotonation of the NH_3^+ groups. The absorption maxima, extinction coefficients, and decay kinetics of the disulfide radical anions, $RSSR^-$, produced on reaction with e^-_{aq} were determined. For most compounds, the maxima were in the range 400–420 nm, with extinction coefficients $\sim 7-15 \times 10^3$ M^{-1} cm^{-1}, and the decays followed a first-order process, except for lipoate which decayed by second-order kinetics. At pH > 7, the decay rate of the $RSSR^-$ radicals of dithiodiacetic, dithiodipropionic, and lipoic acids and of glutathione were independent of pH, whereas all the other disulfides showed an increase in the rate with increase in pH. This increase was shown to follow the pK_a of the amino groups. At pH < 7, the decay rate was found to increase again. This increase in rate was found to be dependent upon $[H^+]$, and the kinetics of protonation of the disulfide radical anions were measured. Values ranged from $6.0 \pm 1.5 \times 10^8$ to $7.0 \pm 1.5 \times 10^{10}$ M^{-1} sec^{-1} for cystine dimethyl ester and glutathione disulfide, respectively. The protonation of $RSSR^-$ probably produces the short-lived sulfenium radical which decomposes to form thiyl RS · radicals ($\lambda_{max} \sim 330$ nm) and RSH. Thiyl radicals were produced by an independent reaction and the transient spectra observed with $\lambda_{max} \sim 330$ nm were shown to be identical with the corresponding radicals formed on protonation of $RSSR^-$ radicals. The reaction of H atoms with these disulfides in acidic solutions was found to produce the same intermediates as those observed from the protonation of $RSSR^-$ radicals, with absorption maxima at ~330 nm and low extinction coefficients indicating a similar rupture of S–S linkages. Decay rates of thiyl radicals ranging from $\sim 3.4 \times 10^9$ to 1.4×10^{10} M^{-1} sec^{-1} were determined. These results are discussed on the basis of the physicochemical properties of the disulfide linkage. The reaction of the radicals produced from lipoic acid differ from those of the other disulfides studied and are discussed separately. (auth)

9413 STRUCTURE OF $(KSO_3)_2NO$ IN X-IRRADIATED SINGLE CRYSTALS OF $(KSO_3)_2NOH$. Hamrick, P. J.; Shields, H.; Gangwer, T. (Wake Forest Univ., Winston-Salem, NC). J. Chem. Phys.; 57: No. 12, 5029-32(15 Dec 1972).

The nitrosyldisulfonate ion was identified in x-irradiated single crystals of potassium hydroxylaminedisulfonate. Principal values of the ^{14}N hyperfine coupling constants are 27.5, 7.7, and 5.5 G. The principal g values are 2.0094, 2.0055, and 2.0026. Weak transitions due to hyperfine interactions with a proton from the host crystal are observed. (auth)

9414 MOESSBAUER STUDIES OF ELECTRON-IRRADIATED FERRICYANIDES. Baggio Saitovitch, E.; Raj, D.; Danon, J. (Centro Brasiliero de Pesquisas Fisicas, Rio de Janeiro). Chem. Phys. Lett.; 17: No. 1, 74-7(1 Nov 1972).

Hydrated ferricyanides are reduced by electron irradiation to the corresponding ferrocyanides, but no effect was observed with nhydrous complexes. Reduction was attributed to hydrogen radicals, which originated from the radiolysis of water. Different results were obtained with silver ferricyanide, which are explained by the formation of an isocyanide bond in the irradiated complex. (auth)

9415 NATURE OF THE FREE RADICALS PRODUCED DURING HIGH-ENERGY IRRADIATION OF ADAMANTANE. Filby, W. G.; Guenther, K. (Kernforschungszentrum, Karlsruhe, Ger.). Chem. Phys. Lett.; 17: No. 1, 150-1(1 Nov 1972).

Contrary to a recent report no evidence was found for the presence of thermally rearranged radicals in γ irradiated adamantane. (auth)

9416 COMMENT ON "ON THE NATURE OF THE FREE RADICALS PRODUCED DURING HIGH-ENERGY IRRADIATION OF ADAMANTANE." Marx, R. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 17: No. 1, 152(1 Nov 1972).

Radiochemistry and Nuclear Chemistry

Hot-Atom Chemistry

9417 ENERGY LOSSES OF HOT ATOMS COLLIDING WITH DIFFERENT MOLECULES. Alfassi, Z. B.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Chem. Phys.; 57: No. 12, 5085-7(15 Dec 1972).

Experimental α values for hot halogen atoms colliding with methyl halides disagree with the calculated values, assuming elastic collisions. This is attributed to the asymmetry of the target molecules, which either render the interaction inelastic or are governed by a different scattering potential. (auth)

9418 COMPUTER SIMULATION OF SOME REACTIONS OF ENERGETIC HYDROGEN ATOMS. Malcolme-Lawes, D. J. (Yale Univ., New Haven). J. Chem. Phys.; 57: No. 12, 5522-30(15 Dec 1972).

A simple hard sphere model of chemical reaction was used to study the reactions of hot hydrogen atoms with H_2, D_2, HD, RH, and RD. The fate of excited products in the presence of rare gases is determined and it is suggested that discrepancies between more exact theoretical treatments and experimental results may be caused partly by the collisional dissociation of excited molecular hydrogen formed at high reaction energies. (auth)

9419 REACTIONS OF ^{125}I ATOMS WITH LIQUID MONOFLUOROBENZENE. Vernois, J.; Abdel Ghani, A. H.; Muxart, R. (Laboratoire, Arcueil, France). Radiochem. Radioanal. Lett.; 12: No. 1, 7-14(9 Nov 1972).

The reaction of nucleogenic ^{125}I atoms with liquid monofluorobenzen. was studied. In the absence of scavengers the total organic yield is 29%, corresponding to 7% o, m, p isomers, 3% iodobenzene, and 19% unidentified products. In the presence of 5×10^{-3} mole % of iodine, the total organic yield decreased to 9%, the yield of o, m, p isomers to 1%, and that of iodobenzene to 0.3%. The isomeric repartition is nearly statistical and is not affected by scavengers. (auth)

9420 INCORPORATION OF HIGHLY ENERGETIC TRITIUM ATOMS IN CIS-CYCLOOCTENE. Jordan, P.; Reichen, W. (Eidgenoessische Technische Hochschule, Zurich). Helv. Chim. Acta; 55: No. 6, 2045-52(1972). (In German).

The substitution, in liquid cis-cyclooctene, of thermal tritium atoms and recoil tritium atoms from the nuclear reaction $^6Li(n,\alpha)^3H$ was studied, and compared to earlier results obtained with cyclohexene. An explanation for the observed very distinct differences is proposed. (auth)

9421 DETERMINATION OF DISTRIBUTION OF TRITIUM ATOMS IN ALIPHATIC MONO- AND DICARBOXYLIC ACIDS. Jordan, P.; Reichen, W. (Eidgenoessische Technische Hochschule, Zurich). Helv. Chim. Acta; 55: No. 6, 2133-8(1972). (In German).

In order to determine the distribution of tritium atoms in non-saturated alicyclic hydrocarbon molecules, a new degradation method which gives higher yields than the methods used heretofore was developed. It is a modification of the method of Hunter–Popjak. Results obtained with palmitic acid as test substance, and with suberic acid as degradation product of cis-cyclooctene, are given. (auth)

9422 DISSOCIATION OF EXCITED HT BY COLLISION WITH RARE-GAS ATOMS. Malcolme-Lawes, D. J. (Yale Univ., New Haven). J. Chem. Soc., Chem. Commun.; No. 23, 1285-6(6 Dec 1972).

A simple hard-sphere model is used to study the fate of HT produced by reaction of hot tritium atoms with hydrocarbons in

the presence of rare-gas moderators; the results suggest that HT may be produced by a high-energy stripping mode of reaction, but that much of this product may dissociate on collision with the moderator, resulting in some cases in an effective excitation function which is comparable to that required by the energy cut-off model. (auth)

9423 EFFECT OF NITRIC OXIDE ON THE THERMAL ANNEALING IN NEUTRON IRRADIATED TRIS(ACETYLACETONATO)COBALT(III). Thomas, V. G. (Bhabha Atomic Research Centre, Bombay). Radiochem. Radioanal. Lett.; 12: No. 2-3, 97-101(29 Nov 1972).

The thermal annealing of recoil damage in neutron irradiated tris(acetylacetonato)cobalt(III) is accelerated by ambient nitric oxide. This is explained by the assumption of an interaction between NO and bis(acetylacetonato)^{60}Co(II), which could be one of the products of recoil, formed initially or during thermal treatment. (auth)

Properties of Radioactive Materials

9424 (ANL-Trans-930) REACTIONS BETWEEN SODIUM AND MIXED OXIDES. Housseau, M.; Dean, G.; Perret, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated for Argonne National Lab., Ill., from Panel on the Behaviour and Chemical State of Fission Products in Irradiated Fuel, Vienna, 7-11 August 1972. 14p. (CONF-720843-2). Dep. NTIS.

In order to predict the possible consequences of an in-reactor cladding rupture, the reactions between sodium and mixed oxides were studied out of the reactor on irradiated and unirradiated fuels. For pure oxides no reaction was observed below 500°C. At 600 to 900°C, the temperature influenced the reaction rate without modifying the final amplitude of swelling or the equilibrium stoichiometry. The volume expansion amplitude was greater the higher the burnup. In a simulation of 16.2 at. % fuel burnup and after 144 hr of treatment at 300°C, the volume expansion was 14 times greater than that observed in a pure oxide after 2000 hr of treatment at 900°C. The fission products insoluble in the matrix (Ru and Mo) had no effect on the reaction. The soluble fission products, such as rare earths or Zr, were responsible for nearly all of the swelling. In order to prevent any reaction, a highly reduced mixed oxide and very highly purified sodium are necessary. (M.C.G.)

9425 CORRELATION OF ENERGY BONDS WITH INTERNUCLEAR DISTANCES FOR DIATOMIC HYDRIDES. Mastryukov, V. S. (Moscow State Univ.). Zh. Strukt. Khim.; 13: No. 4, 576-80(1971). (In Russian).

Diatomic hydrides may be divided into two groups; in each of these groups the dissociation energy is a constant value. A graphical method is shown for predicting dissociation energies, and probable values of such are given for a number of hitherto uninvestigated molecules: ScH, TiH, VH, CrH, MnH, ZrH, NbH, MoH, TcH, RuH, RhH, PoH, AtH, FrH, and RaH are of particular interest here. (K.S.W.)

9426 14-COORDINATE URANIUM(IV). THE STRUCTURE OF URANIUM BOROHYDRIDE BY SINGLE-CRYSTAL NEUTRON DIFFRACTION. Bernstein, E. R. (Princeton Univ., NJ); Hamilton, W. C.; Keiderling, T. A.; (and others). Inorg. Chem.; 11: No. 12, 3009-16(Dec 1972).

The structure of $U(BH_4)_4$ was refined by a single-crystal neutron diffraction study. The x-ray structure (tetragonal, $P4_32_12$ ($P4_12_12$), a = 7.49 (1) Å, c = 13.24 (1) Å, Z = 4, ρ_{calcd} = 2.66 g/cm^3) was confirmed and, in addition, all hydrogen atoms were located to a precision of 0.04 Å. Four of the six BH_4^- ions surrounding each uranium atom are attached to it by two hydrogen atoms, and use their remaining two hydrogen atoms to bridge neighboring uranium atoms in a helical polymeric structure. Two additional tetrahydroborate groups in a cis configuration are bonded to the uranium atom by three hydrogen atoms, resulting in an overall coordination number of 14. The mean U-H bond length is 2.38 (2) Å. The BH_4^- ions are approximately tetrahedral with a mean B-H distance (corrected for thermal motion) of 1.29 (4) Å. A capped hexagonal antiprism is considered to be a useful reference coordination polyhedron, and distortions from this idealized geometry are described. The difference between the solid-state structures of $Zr(BH_4)_4$ and $U(BH_4)_4$ is discussed in terms of sphere packing and molecular orbital considerations. The results were also used in conjunction with diffraction data on other metal tetrahydroborate compounds and with tabulated ionic radii to develop a single and consistent picture in which the metal-boron distance is shown to correlate with the geometry of the metal borohydride attachment. (auth)

9427 NATURE OF URANIUM BOROHYDRIDE IN ITS VAPOR AND SOLID PHASES FROM INFRARED SPECTRA. James, B. D. (Univ. of Queensland, Brisbane); Smith, B. E.; Wallbridge, M. G. H. J. Mol. Struct.; 14: No. 2, 327-9(Nov 1972).

The infrared spectrum of vapor phase uranium borohydride was determined and compared with the solid phase spectrum. Results indicated a structural transformation on passing from the solid to the vapor phase. In the vapor phase $U(BH_4)_4$ is monomeric, with each boron atom bonded through three hydrogen bridges to the metal atom. (M.C.G.)

9428 ELEMENTARY MOLECULAR ORBITAL CALCULATION ON $U(C_8H_8)_2$ AND ITS APPLICATION TO THE ELECTRONIC STRUCTURES OF $U(C_8H_8)_2$, $Np(C_8H_8)_2$, AND $Pu(C_8H_8)_2$. Hayes, R. G.; Edelstein, Norman (Univ. of Notre Dame, IN). J. Amer. Chem. Soc.; 94: No. 25, 8688-91(13 Dec 1972).

Molecular orbital calculations were performed on $U(C_8H_8)_2$ using the Wolfsberg-Helmholz approximation. The results of these calculations were used to analyze the information available on $U(C_8H_8)_2$, $Np(C_8H_8)_2$, and $Pu(C_8H_8)_2$, with some success. The most striking prediction of the model is that the ground state of $U(C_8H_8)_2$ should have $|J_z| = 3$, which seems to be correct. (auth)

9429 SUBSTITUTION REACTIONS OF 1,1'-DIMETHOXYURANOCENE AND 1,1'-BIS(URANOCYL)TRIMETHYLAMMONIUM IODIDE WITH ORGANOLITHIUM REAGENTS. Harmon, C. A.; Streitwieser, A. Jr. (Univ. of California, Berkeley). J. Amer. Chem. Soc.; 94: No. 25, 8926-7(13 Dec 1972).

Dimethoxyuranocene was prepared and reacted with alkyllithium compounds. The uranocene derivative of dimethylaminocyclooctatetraene was reacted with methyl iodide and then with alkyllithium compounds. The most reasonable reaction mechanism appeared to involve a carbanion chain sequence initiated by mutation of the substituted uranocene at the position adjacent to the heterosubstituent and involving as an intermediate a uranium complex of cyclooctatrienyne. (M.C.G.)

9430 CHEMISTRY OF URANIUM. Pt. 7. THERMODYNAMIC ASPECTS OF URANIUM TETRACHLORIDE COMPLEXES. Du Preez, J. G. H.; Koorts, J. (Univ. of Port Elizabeth, South Africa). Inorg. Nucl. Chem. Lett.; 9: No. 1, 99-107(Jan 1973).

During previous work in which the object was to assess the relative importance of size, structure and donor strength of neutral oxygen donor ligands upon stoichiometry, structure and stability of their uranium tetrachloride and tetrabromide complexes, it became clear that quantitative thermodynamic data are needed to assess the donor strength aspect. Since the interest was not only in thermodynamic data, but also its relationship towards stiochiometry (UCl_4-ligand mole ratios) it was decided to use enthalpimetric titrimetry, which provided this information simultaneously. The apparatus is described and results are discussed. (auth)

9431 COMPLEXES OF URANIUM(IV). 1-ADDUCTS OF URANIUM TETRACHLORIDE WITH 2,2'-BIPYRIDINE AND 1,10-PHENANTROLINE. Doretti, L.; Sitran, S.; Zanella, P.; Faraglia, G. (Consiglio Nazionale delle Richerche, Padua). Inorg. Nucl. Chem. Lett.; 9: No. 1, 7-12(Jan 1973).

The preparation of both uranium tetrachloride adducts from the reagents in dimethoxyethane (DME) is reported. UCl_4 forms a stable complex with DME, having the formula $UCl_4 \cdot 2DME$, but this ligand is easily removed by bipyridine and phenanthidine. The adducts precipitate in a pure form also in the presence of an excess of ligand. They have been characterized by ir and visible spectra. (auth)

9432 SUBLIMATION PRESSURE OF THORIUM TETRACHLORIDE. Knacke, O.; Mueller, Franz; van Rensen, E. (Rheinische-Westfaelische Technische Hochschule, Aachen). Z. Phys. Chem. (Frankfurt); 80: No. 1/2, 82-90(Aug 1972). (In German).

The sublimation pressure of $ThCl_4$ was measured by the Knudsen effusion method between 400 and 600°C. The vapor pressure curve, the normal entropy, the sublimation enthalpy, and the vapor pressure constant were determined. On the basis of the experimental results, both the sublimation enthalpy and the vapor pressure constant were computed for 0°K. (H.B.G.)

9433 THERMAL DISSOCIATION OF $ThOCl_2$ AS WELL AS OF $UOCl_2$ AND UO_2Cl_2. Knacke, O.; Mueller, Franz; van Rensen, E. (Rheinisch-Westfaelische Technische Hochschule, Aachen). Z. Phys. Chem. Frankfurt); 80: No. 1/2, 91-100(Aug 1972). (In German).

The thermal dissociation of solid $ThOCl_2$ and $UOCl_2$ in dioxide and tetrachloride was studied according to the Knudsen effusion method at temperatures between 420 and 750°C. From the experimental data, both formation enthalpy and normal entropy of the oxides were computed. UO_2Cl_2 decays into UO_2 and Cl_2 through the intermediary formation of U_3O_8 and U_4O_9. Both formation and decay of the oxychlorides were discussed by means of diagrams. The melting point of UO_2Cl_2 was determined as 577°C. (H.B.G.)

Radioactive Waste Treatment

9434 (ARH-SA-126) ULTIMATE STORAGE OF RADIOACTIVE WASTES IN TERRESTRIAL ENVIRONMENTS. Isaacson, R. E.; Brownell, L. E. (Atlantic Richfield Hanford Co., Richland, Wash.). Aug 1972. Contract AT(45-1)-2130. 33p. (CONF-721107-4). Dep. NTIS.

From Symposium on the management of radioactive wastes from fuel reprocessing; Paris, France (27 Nov 1972).

New avenues are opened for the ultimate storage of radioactive wastes via the "STOPPER" and "Thermalt" processes. STOPPER is the Stone Process for Permanent Encapsulation of Radionuclides, a hydrothermal process. Thermalt is a pyrochemical process for fixing radionuclides in a basalt-like product. The products contain analogs of silicate and aluminosilicate minerals such as pollucite, strontium feldspar and "plutonite"—a structural analog of zircon. Ultimate storage will have been effected if these product forms are secured in geochemically compatible media where the authigenic precipitation of cation aluminosilicates will provide additional protection from transport by groundwater movements. (auth)

9435 (ARH-SA-133) HIGH-TEMPERATURE PROCESSES FOR IMMOBILIZATION OF HANFORD IN-TANK SOLIDIFIED WASTE. Kupfer, M. J.; Schulz, W. W. (Atlantic Richfield Hanford Co., Richland, Wash.). Sep 1972. Contract AT(45-1)-2130. 9p. (CONF-721109-13). Dep. NTIS.

From International conference on nuclear solutions to world energy problems; Washington, D. C. (12 Nov 1972).

Several high-temperature methods for conversion of these and other high-level wastes to immobile silicate and aluminosilicate forms suitable for long-term disposal and/or storage are summarized. The principal reaction in the thermite processes is $4Fe_2O_3 + 3Si \rightarrow 3Fe_2SiO_4 + 2Fe$; $\Delta H = -245$ cal, which serves as a source of heat energy to melt the feed ingredients. Substitution of MnO_2 for Fe_2O_3 appears potentially desirable to reduce the amount of metal by-product and to decrease slightly water leachability of the silicate glass. The Basalt Melt process involves melting a mixture of radioactive waste and powdered basalt to produce a nonleachable glass. A basalt-ITS waste containing 10 to 40 wt % waste may be melted to produce a product with suitable leaching characteristics. (M.C.G.)

9436 (DOCKET-50201-135) WEST VALLEY REPROCESSING PLANT. Low Level Liquid Waste Treatment Facility, Summary Report No. 9. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 14 Dec 1972. 21p. Dep. NTIS.

The performance of the low-level waste treatment facility from September 1972 to December 14, 1972 is summarized and the current status of development work reviewed. Concentrations of ^{90}Sr, ^{137}Cs, gross β, and $^{106}RuRh$ in the effluents are shown. Important operating variables include: sodium concentration, filter effluent hardness, chemical stability, and condition of resin. (M.C.G.)

9437 (DOCKET-50201-136) WEST VALLEY REPROCESSING PLANT. Request to Continue Operations under Interim Specifications. (Nuclear Fuel Services, Inc., Rockville, Md.). 19 Dec 1972. 2p. Dep. NTIS.

The low-level waste treatment facility is removing more than 94% of the ^{137}Cs and more than 99% of the ^{90}Sr from the treated effluents. However, thus far, the facility has not been able to routinely meet the requirements that would be imposed if Change No. 15 were adopted. Therefore, approval is requested to continue operations under previously established interim specifications on liquid effluents, at least until reprocessing operations are resumed at the plant. (M.C.G.)

9438 (ORNL-TM-3964) NEUTRON-INDUCED TRANSMUTATION OF HIGH-LEVEL RADIOACTIVE WASTE. Claiborne, H. C. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 89p. Dep. NTIS.

The possibility of reducing the potential hazard of high-level radioactive waste by neutron-induced transmutation has received little study. The available information on fission product transmutation is reviewed and discussed, the contribution of individual actinides to the potential hazard of the waste is calculated, and expected hazard reduction factors that would result from recycle through a PWR are calculated for the actinide waste from chemical processing of spent fuel. It is not practical to burn fission product wastes in power reactors because the neutron fluxes are too low. Developing special burner reactors with the required neutron flux of the order of 10^{17} n/cm^2 · sec or burning in the blankets of thermonuclear reactors is beyond the limits of current technology. It seems that ultimate storage in deep geological formations, such as bedded salt, remains the best method for fission product disposal. When plutonium and uranium extraction efficiencies exceed 99%, a significant reduction in the long-term hazard potential of the waste can be obtained by similar removal of neptunium, americium, and curium (the other actinides being very small contributors). Consequently, it seems reasonable to concentrate on developing economical chemical processes to extract these three actinides for separate storage or for recycling through the reactors that produce them. The results of such recycling calculations show that the long-term hazard potential of the waste from light water reactors may be reduced by factors up to 200 if no more than 0.1% of the actinides are discarded to the waste in each pass through the reprocessing plant. Larger reductions of the hazard potential of the waste will become practical if methods are developed to produce sharper separations between the actinides and fission products as the spent fuel is processed. (auth)

9439 CONTROL AND DISPOSAL OF RADIOACTIVE WASTES. Lewis, J. B. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Eng. (London); No. 267, 425-8 (Nov 1972).

A brief summary is given of sources of radioactivity in the nuclear industry and the associated hazards. Methods of protecting those working with radioactive materials and also the general public are described in relation to both the disposal of radioactive waste and the techniques of waste treatment. (UK)

Radioisotope Production

9440 SELECTIVE SEPARATION OF FISSION TECHNETIUM USING SOLID CHLORIDES. Neidhart, B.; Baechmann, K.; Kraemer, S.; Link, I. (Technische Hochschule, Darmstadt, Ger.). Radiochem. Radioanal. Lett.; 12: No. 1, 59-69(9 Nov 1972).

Fission products induced by fission of ^{235}U were stopped in solid KCl and $SrCl_2$ catchers. At temperatures of 300 to 750°C, 30 to 85% of Tc was selectively released. The delay times of the release of Tc compounds are in the range of 25 to 200 sec. Purified nitrogen was used for the transportation. The release of Tc was accelerated by increasing the temperature and adding $ZrCl_4$ as a carrier. The reaction process is discussed. The formation of the compound at the surface is possibly the rate-determining step. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 11264.

9441 (GERHTR-34) THERMOCHEMISTRY OF THE SYSTEMS U, Th, Pa, C, O_2, AND Cl_2. Krahe, Josef; Mueller, Franz (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Dec 1968. 38p. (JUL-565-CT). Dep. NTIS.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

The thermochemical principles of chlorination volatilization for spent fuel processing are given. They are presented in the form of various state diagrams based on literature and estimated data. (M.C.G.)

9442 (K-L-6292) RECENT DEVELOPMENTS IN CONTROLLING THE RELEASE OF NOBLE GASES BY ABSORPTION IN FLUOROCARBONS. Stephenson, M. J.; Merriman, J. R.; Dunthorn, D. I. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 12 Jun 1972. Contract W-7405-eng-26. 14p. (CONF-720607-29). Dep. NTIS.

From 18th annual American Nuclear Society conference; Las Vegas, NV (18 Jun 1972).

Several years of testing have shown that the selective absorption process continues to show considerable potential for application to a variety of air cleaning jobs, including off-gas cleanup at a fuel reprocessing plant. Preliminary impurity scoping tests indicate that the process has a high tolerance for some of the major off-gas impurities expected to be generated in fuel reprocessing plants. (auth)

9443 (K-L-6294) EXPERIMENTAL DEMONSTRATION OF THE SELECTIVE ABSORPTION PROCESS FOR KRYPTON-XENON REMOVAL. Stephenson, M. J.; Merriman, J. R.; Dunthorn, D. I.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 1972. Contract W-7405-eng-26. 15p. (CONF-720823-16). Dep. NTIS.

From 12th air cleaning conference; Oak Ridge, TN. (28 Aug 1972).

The applicability of the selective absorption process to reactors and fuel reprocessing plants was investigated. Recent data show that the process can be operated efficiently at low concentrations of krypton, as well as at high levels; can remove xenon at least as

effectively as krypton; and can separate the noble gases from carrier gases other than air. Also, the process continues to separate krypton efficiently when the feed becomes contaminated with nitrogen oxides and carbon dioxide and, in fact, has a high tolerance for these impurities. Furthermore, it appears that any iodine and methyl iodide passing into the system collect in the solvent and could be removed from the liquid stream, if desired, by treatment of the recycle solvent. (auth)

ENGINEERING

Energy Conversion

Refer also to abstracts 9491, 9506, 9516, 9790, 9791, 9794, 9795, 9803, 9940, 9949, 9965, 9966, 10019, 11483, 11487–11494, and 11496–11498.

9444 (BNL–17252) GLOBAL ENERGY NEEDS. Sailor, V. L. (Brookhaven National Lab., Upton, N. Y.). 14 Oct 1972. 13p. (CONF-721050–1). Dep. NTIS.

From International convocation: 1972 meeting; New York, NY (14 Oct 1972).

The production and uses of energy through the world are discussed. Relations between advancement in the various societies and their energy consumption are noted. Data and discussions are included on per capita energy use in selected countries, total energy consumed in selected countries and by continent, and energy exporters. (J.R.D.)

9445 (BNL–17280) UNITED STATES ENERGY CRISIS: SUPPLY AND DEMAND. Sailor, V. L. (Brookhaven National Lab., Upton, N. Y.). [nd]. 43p. (CONF-721042–1). Dep. NTIS.

From Science Teachers Association annual meeting; Kiamesha, NY. (23 Oct 1972).

Alternatives to the present pattern of energy production processes are discussed. Discussions are included on US energy balance, generation of electricity, environmental effects of energy production and use, and air pollution. (J.R.D.)

9446 ANALYSIS OF ELECTRICAL CHARACTERISTICS OF THE NONEQUILIBRIUM MHD GENERATOR BY THE FOUR-TERMINAL NETWORK THEORY. Shirakata, H. (Japan Atomic Energy Research Inst., Tokai). Jap. J. Appl. Phys.; 11: No. 12, 1837-50(Dec 1972).

The basic circuit equivalent to the two-dimensional Ohm's law is expressed as the active network including a current-voltage transducer and a negative resistance. The network for a multi-electrode Faraday generator with the flow of three layers consisting of a free stream layer and two boundary layers is derived by combining the basic equivalent circuits. The steady state solutions of currents, voltages, and electron temperatures in the nonequilibrium generator are obtained. In the calculation the loss mechanisms due to electrothermal instability, boundary layer, and wall-leakage currents are considered. From the results of the numerical calculation it is found that the instability has an important role in reducing the electron temperature difference between a free stream and a boundary layer and in preventing the boundary layer leakage current. The theoretical and the experimental results are in good agreement. (auth)

9447 ENERGY 70, PROCEEDINGS. Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada, September 21–25, 1970. Volume 1. Hinsdale, Ill.; American Nuclear Society (1970). 895p. (CONF-700912–(Vol.1)).

One hundred thirty-six papers were presented. A separate abstract was prepared for each of 51. Nine papers were previously abstracted in NSA. For abstracts of these see CONF-700912-(Vol.1) in the Report Number Index. The remaining 76 papers dealing with advanced energy concepts, non-nuclear energy conversion systems, Brayton cycle system technology, and heat transfer studies related to energy conversion were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 9448–9470, 9516, 9546, 9584, 9789–9802, 9940, 9948, 9949, 9965, 9966, 10019, and 11481–11485.

9448 SOME NOTES ON FUTURE INDUCTIVE MPD CONVERTERS WITH CONTROLLED NUCLEAR FUSION. Peschka, W.; Henry, R.; Eitel, H.; Seeger, W. (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e. V., Stuttgart). pp 1.61-4 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Technical realization of controlled nuclear fusion provides methods for obtaining plasmas with high electrical conductivities and flow velocity. Electrical power may be extracted from such energy sources using inductive interaction with electromagnetic waves. Inductive magnetoplasmadynamic (MPD) converters are advantageous in that the plasma flow is not in direct contact with electrodes and channel walls. Geometric dimensions and scaling parameters are dictated by the following criteria: 1) flow velocity is greater than the phase velocity of the electromagnetic wave; 2) wavelength in converter section has reasonable length for feasibility of construction; and 3) dimensions of the converter are large compared to the Debye shielding distance. Design considerations include the influence of operating frequency and electrical conductivity on the plasma interaction. Some interesting aspects are discussed concerning integration of the MPD converter and a suitable energy source. (auth)

9449 SURVEY AND COMPARISON OF THE SUPERCRITICAL AND DISSOCIATING GAS POWER CYCLES. Luchter, Stephen (Mechanical Tech. Inc., Latham, NY). pp 2.1-5 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Cycles which exhibit significant real gas effects are receiving increasing attention. In particular, much work has been reported on the supercritical cycle with carbon dioxide as the working fluid, and the dissociating gas cycle with N_2O_4 or Al_2Cl_6 as the working fluid. The results reported in the literature are reviewed and a discussion of their possible significance presented. It is concluded that the N_2O_4 cycle may be slightly more attractive than the CO_2 cycle, but that a choice cannot be made without additional information on suitable materials. (auth)

9450 ELECTROKINETIC POWER GENERATION. Burgreen, D.; Hildreth, D. (Polytechnic Inst., Brooklyn). pp 2.6-10 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A theoretical study was made of electrokinetic power generation. It was found that an electrokinetic power generation efficiency as high as six percent is obtainable when a dilute water solution is pumped through a capillary slit with a channel width of 2×10^{-5} cm. The difference in the mobilities of the ions that are present is observed to have a pronounced effect on the magnitude of the efficiency. Parametric analytical equations are correlated with the phenomenological equations of irreversible thermodynamics. Graphical presentations relate the power generation efficiency to electrokinetic parameters. (auth)

9451 EXPERIMENTS IN ELECTROKINETIC POWER GENERATION. Burgreen, D.; Notaro, A.; Bilenchi, R. (Polytechnic Inst., Brooklyn). pp 2.11-13 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Experiments were undertaken to demonstrate the feasibility of generating power by pumping distilled water through porcelain capillary elements. The power conversion efficiency of a power generating cell in a system containing an external electrical load, was determined from the experimental data. The results of the experiments are encouraging since power conversion efficiencies of about 0.4% were obtained with the use of ordinary distilled water. Curves plotted from the experimental data show a variation of efficiency of power conversion with applied pumping pressure. Such a variation has not been predicted by electrokinetic theory. (auth)

9452 MECHANO-CHEMICAL TURBINE: A NEW POWER CYCLE. Sussman, M. V. (Tufts Univ., Medford, MA); Katchalsky, A. pp 2.14-16 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A basic thermodynamic cycle for the production of mechanical power from materials that may be made to contract forcibly and reversibly, is described. The cycle differs from existing mechanical power cycles which generally employ expanding fluid working substances. A "contraction turbine" operating on this cycle was devised, which employs collagen fiber as its working substance and salt solution as fuel, and produces mechanical work directly from chemical free-energy. Direct conversion of chemical to mechanical energy is routinely effected in muscle but not in usual man-made engines. (auth)

9453 REVIEW OF LIQUID-METAL MAGNETOHYDRODYNAMIC SPACECRAFT ENERGY CONVERSION CYCLES. Morse, F. H. (Univ. of Maryland, College Park). pp 2,44-50 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Interest in liquid-metal magnetohydrodynamic (LM-MHD) power generation has developed because of its high power density, its ability to operate both ac and dc generators, and the possibility of operation at moderate temperatures. Recent efforts and advances in LM-MHD have made the evaluation of such systems for spacecraft power supply feasible. The principal LM-MHD power generation cycles are described and their efficiencies compared. (auth)

9454 PARAMETRIC SURVEY OF GAS CORE REACTOR: MHD POWER PLANT CONCEPTS. Williams, J. R.; Kalifelz, J. M.; Shelton, S. V. (Georgia Inst. of Tech., Atlanta). pp 2,51-7 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The gas core reactor appears to be an ideal heat source for large power plants using an MHD topping cycle. The advantages of such a power plant would include a thermal efficiency of the order of 70% or higher, the possibility of continuous fuel reprocessing, and the elimination of fuel element handling problems. The two-gas core reactor concepts currently receiving the most attention are designed for nuclear rocket propulsion and use hydrogen as the working fluid. The substitution of argon should enhance the operating characteristics of these reactors for MHD power applications. The technology for operating MHD generators with argon is well established. Reactors utilizing a fissile gas as the working fluid would have several advantages over the nuclear rocket reactors for power generation; however, the feasibility of operating an MHD generator with a gas containing a sizable percentage of uranium or plutonium has not been demonstrated. Diffusion and transport calculations indicate that a gas core fast breeder reactor using a single working fluid of plutonium or a suitable compound may be feasible and could operate at pressures below 5000 atmospheres. A breeding ratio of about 2 is predicted. (auth)

9455 ELECTROHYDRODYNAMIC (EHD) FLOWS AND SOME EFFECTS OF TURBULENCE ON THESE FLOWS. Biblarz, Oscar (Naval Postgraduate School, Monterey, CA). pp 2,58-63 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Some effects of turbulence in flows which convect charged particles through an electric field are discussed. A potential application of such a process is in direct energy conversion. The field of electrohydrodynamics is briefly surveyed. It is pointed out that the parameters of the charged-particle injector are critical in the operation of such devices. The degree of turbulence can affect the breakdown field and heuristic arguments are presented concerning the qualitative effects of turbulence. Spectral measurements of turbulence intensity and EHD currents are reported, and some inferences are drawn about the relation between them. (auth)

9456 INVESTIGATION OF A LIQUID-METAL MAGNETOHYDRODYNAMIC POWER SYSTEM. Elliott, D. G.; Hays, L. G.; Cerini, D. J.; Bogdanoff, D. W. (Jet Propulsion Lab., Pasadena, CA). pp 2,64-73 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Liquid-metal magnetohydrodynamic power conversion is being investigated for nuclear-electric propulsion. A liquid-metal MHD converter has no moving mechanical parts and requires a heat source temperature of only 1300°K. Cycle efficiencies of 5% to 8% for single-stage converters and 10% for multistage converters appear attainable. The specific weight of a 240 kWe MHD power plant has been estimated as 30 kg/kWe with shielding for unmanned science missions. Liquid-metal MHD converters use cesium vapor to accelerate lithium in a two-phase nozzle. The cesium is separated from the lithium, condensed, and returned to the nozzle while the lithium flows through an AC MHD generator and diffuser and returns through the heat source to the nozzle. Component performance has been measured for two-phase nozzles, separators, and diffusers using water–nitrogen and NaK–nitrogen mixtures and for generators using NaK. Converter tests have been conducted with water–nitrogen and NaK–nitrogen mixtures to assess component interactions and start-up behavior. Materials compatibility has been investigated for impact and flow of lithium at velocities of 70 m/s at 1370°K. Extrapolation indicates Nb–1 Zr alloy to be satisfactory for 10,000 hours operation at the lithium velocity of 150 m/s in a converter. Progress made in liquid-metal MHD system studies and in component and converter experiments is previewed. (auth)

9457 OPTIMIZATION OF A LINEAR NON-EQUILIBRIUM MHD GENERATOR. Zauderer, B. (General Electric Co., King of Prussia, PA). pp 2,74-80 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Based on the results of an experimental study of a supersonic, non-equilibrium MHD generator, a theoretical optimization of such a generator was performed. It was found that neon seeded with less than 0.1% cesium was the optimum generator working fluid. The maximum generator power output and efficiency was obtained in a constant current density generator operating with a favorable pressure gradient. The optimum channel geometry had an exit to entrance area ratio of about six, linearly diverging channel walls, and a length to average diameter ratio of about ten. It was also shown that a constant velocity generator with a linearly diverging channel geometry had a very low generator conversion efficiency. (auth)

9458 NEW CONCEPTS IN MECHANICAL ENERGY STORAGE. Rabenhorst, D. W. (Johns Hopkins Univ., Silver Spring, MD). pp 2,95-9 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The conventional flywheels used in the Swiss Oerlikon bus and in the British Gyreacta bus and automobile transmissions produced approximately three watt-hours per pound of flywheel weight. An optimized flywheel shape was used more recently in an experimental aircraft control system to provide short time peak power and to reduce weight. It had an energy storage capability of 12.9 watt-hours per pound. By way of comparison, a lead-acid battery can store 8 to 10 watt-hours per pound. A filament wound fiber glass flywheel which produced about 18.5 watt-hours per pound is described, and it is predicted that filament-wound wheels should ultimately have the capability of producing more than 30 watt-hours per pound. A new super flywheel configuration is described along with several additional improvements which should allow consideration of many flywheel applications which would not otherwise be practical. (auth)

9459 HIGH VOLTAGE GENERATION WITH A BETA ELECTROGENERATOR CELL. Low, C. A. Jr. (Lewis Research Center, Cleveland). pp 2,113-18 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The direct conversion of the radioactive decay energy of a beta emitter, cerium-144, into high voltage electricity has been investigated in a coaxial cylinder cell. A 100 curie beta source absorbed in a thin graphite band on a 28 centimeter inner cylinder constituted the energy source. The energy spectrum and the output voltage were measured with a semiconductor detector. At vacuums between 1×10^{-7} and 2×10^{-4} torr, the maximum voltage was limited to 50 to 75 kilovolts, even when the electrodes were preconditioned to a higher voltage. Introduction of argon at pressures near 5×10^{-4} torr increased this voltage capability to about 200 kilovolts. (auth)

9460 REVIEW OF THE NASA BRAYTON SYSTEM TECHNOLOGY PROGRAM. Rochen, Herb (Office of Advanced Research Tech., Washington, DC). pp 4,1-5 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Nearly a decade of work in the NASA program for developing a Brayton Space Power System is reviewed. The program objectives were to determine if the necessary high-efficiencies could be achieved in low-power gas turbomachinery and if reliable long-life gas bearing-mounted components could be built and demonstrated. The feasibility studies and development work on a single-shaft Brayton cycle power conversion system for manned orbiting

space stations, on radioisotope heat sources for Brayton cycle engines, and on future larger Brayton power conversion systems using a reactor are discussed. (L.C.L.)

9461 DESCRIPTION AND PERFORMANCE OF THE ELECTRICAL SUBSYSTEM FOR A 2 TO 15 kWe BRAYTON POWER SYSTEM. Thollot, P. A.; Bainbridge, R. C.; Nestor, J. (Lewis Research Center, Cleveland). pp 4.34-42 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The electrical subsystem of the 2 to 15 kWe Brayton power system includes the engine control system, the electrical control package, the dc power supply package, the inverters, and required instrumentation. This subsystem has undergone extensive experimental evaluation both on an individual component basis and as part of the complete flight configured power system. Tests were performed under a variety of conditions including high and low ambient temperatures, vacuum and atmospheric pressures, steady state and transient operating modes and at design as well as off-design conditions. The electrical subsystem is described, and performance characteristics of individual components and of the subsystem when mated to the complete Brayton power system are discussed. (auth)

9462 ENGINEERING OF ENERGY EFFECTS WITH AN EXPANDING WORLD POPULATION. Bjerklie, J. W. (Mechanical Tech. Inc., Latham, NY). pp 6.1-8 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The life-quality problems associated with an exponentially expanding world population and its energy needs are discussed by considering energy uses, energy sources, uses of energy, the heat balance between the earth and its atmosphere, sources and effects of heat release, and engineering approaches to analyzing and systematically proposing solutions to these multiple problems. (L.C.L.)

9463 THERMOELECTRIC GENERATORS POWERED BY THERMAL WASTE FROM ELECTRIC POWER PLANTS. Shirazi, M. A. (Pacific Northwest Water Lab., Corvallis, OR). pp 6.17-24 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The feasibility of recovering electricity from the waste heat of electric power plants was assessed. Sources considered were: stack flue gas, gas-turbine exhaust, and condensing steam. Typical 1600 MW fossil-fuel steam plants and gas-turbine plants were used as examples. Flat plate heat exchangers were designed with thermoelectric couples arranged in series within the plates. Heat flux, conversion efficiencies, and flow friction losses were calculated. Except for the condenser application, the friction losses are several times the thermoelectric power generated. Under favorable conditions, 3 to 9 MW is obtainable from the thermoelectric condensers. The high material cost, however, precludes all such applications today. (auth)

9464 COAL COMBUSTION SYSTEM FOR MHD GENERATORS. Zelinski, J. J.; Teno, J.; Westra, L. F. (Avco Everett Research Lab., Everett, MA). pp 7.41-8 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A system for burning pulverized coal at high pressure with preheated, oxygen-enriched air at high volumetric heat release rates was developed. The experimental program showed that a residence time of 30 milliseconds is sufficient to obtain over 95% combustion efficiency. Volumetric heat release rates of the order of 10^7 Btu/hr/ft^3 were obtained. Heat flux in an insulated combustion chamber of 10×10^4 Btu/hr/ft^2 was measured. A wide variety of coals can be handled by the system, with the indication that low-grade coals can be used without difficulty. (auth)

9465 DESIGN AND DEVELOPMENT OF THE SNAP-23A ISOTOPE POWERED TERRESTRIAL POWER GENERATION SYSTEM. Bernard, A. M. (Westinghouse Electric Corp., Pittsburgh); Van Bibber, L. E.; Wharam, J. L. pp 8.46-50 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A 60-watt radioisotope fueled system has been under development for remote location applications. The SNAP-23A system is designed to meet stringent efficiency requirements and environmental conditions as well as shipping, handling, and operating hazards. Heat from the ^{90}Sr fuel is conducted up through the U–8 Mo alloy shield and copper heat accumulator to the thermoelectric converter. Heat losses are minimized with an efficient insulation system. The thermoelectric converter uses segmented N- and P-type legs for maximum efficiency of heat conversion to electricity. Test results have been accumulated for six thermoelectric converters, one electrically heated system on test for over 14,000 hours and one isotopic fueled system on test since February 1970. (auth)

9466 STEP III THERMOELECTRIC POWER SYSTEM. DesChamps, N. H. (Sanders Nuclear Corp., Nashua, NH); Berlin, R. E. pp 9.19-24 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A compact 25 watt double-ended radioisotope powered thermoelectric generator for deep sea or terrestrial use was developed. The system has a five year design life and utilizes ^{90}Sr fuel capsule radiating heat to a RCA converter consisting of cascaded SiGe–BiTe thermoelectric couples. Vacuum-reflective thermal insulation is placed interior to the depleted uranium shielding to allow the shielding to act as the structural member at ocean depths up to 23,000 ft. A steel outer housing serves as the corrosion barrier. A high modulus oil fills the annulus between the outer housing and the shielding and serves to transmit the hydrostatic pressure to the shield material. Tests being performed indicate an initial system efficiency greater than 10% and an end of life efficiency of greater than 9%. Design and test data describing the STEP III generator are presented. These data include generator system design, fuel capsule design, generator safety analysis, and electrical performance characteristics. (auth)

9467 STRUCTURAL FAILURES IN LIGHT WEIGHT SOLAR CELL ARRAYS UNDER THERMAL CYCLING. Stanley, A. G. (Massachusetts Inst. of Tech., Lexington). pp 10.1-6 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Several different types of small silicon solar cell arrays mounted on light weight honeycomb panels and on flexible substrates were subjected to long term thermal cycling tests at temperatures from –150°C to 60°C in dry nitrogen. Other tests included immersion in liquid nitrogen and vibration fatigue tests in excess of one million cycles. The arrays experienced a reduction in output caused by contact failure, fracture in the silicon and cover slide and by disintegration of the honeycomb. Failure modes caused by different cell and interconnect constructions are compared. (auth)

9468 USE OF A CAVITATING PUMP FOR CONTROL OF A POTASSIUM RANKINE CYCLE SYSTEM. Gnadt, P. A.; Yarosh, M. M. (Oak Ridge National Lab., TN). pp 11.39-44 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

An experiment to determine the feasibility of using a cavitating pump for liquid inventory control of a single-loop Rankine cycle system was operated for 3600 hr. Potassium was the working fluid and potassium vapor generated in an electrically heated boiler was used to drive a turbine-driven pump. The turbine-driven pump, operating on liquid-potassium-lubricated bearings, served as the boiler feed pump and a turbine-generator unit was simulated by a throttle valve located in a bypass line. The method of achieving liquid inventory control depended on the variation in pump performance as a function of the change in net positive suction head on the pump. The functional control was fixed by the pump and the system design and required no instruments or automatic circuitry to accommodate changes in system power. The system operated totally unattended for sustained periods. The containment system components were fabricated from AISI Types 316 and 304 stainless steel and operated at temperatures up to 1540°F. No indication of corrosion or erosion was observed on the pump unit of the vapor-driven turbine pump after 2550 hr of operation under cavitation control conditions. (auth)

9469 6 kWe ORGANIC RANKINE POWER CONVERSION SYSTEM FOR SPACE APPLICATIONS. Niggemann, R. E.; Bland, T. J.; Wigmore, D. B. (Sundstrand Aviation, Rockford,

IL). pp 11.56-61 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

An organic Rankine cycle power conversion system designed, built, and tested at Sundstrand Aviation is described. The status of this program is presented. (auth)

9470 ORGANIC RANKINE POWER UNIT TESTING. Barret, R. W.; Garcia, R.; Waters, W. M. (Aerojet Nuclear Systems Co., Azusa, CA). pp 11.62-6 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

This is a report of the design, fabrication, and testing of a 6 kW(e) Organic Rankine-Cycle power system employing a jet condenser. The objective of the program was to determine whether a jet-condenser-modified system could be operated at or near 0.1 psia turbine exhaust pressure. This program is a follow-on to the 12 kW(e) 0.5 psia unit operated by Aerojet in 1966. In order to obtain the increased turbine expansion from a 700°F, 107 psia inlet condition, the following technological developments were required: a jet condenser capable of full condensation and pressure recovery while operating at 2500 to 1 vapor-to-liquid volume ratio and a nozzle and turbine wheel operated at 1000 to 1 expansion ratio. In addition to these state-of-the-art extensions, an improved visco seal system was incorporated into the rotating unit, and an all-aluminum regenerative-heat-exchanger replaced the much heavier copper unit used in the earlier system. The hardware design objectives, performance, and system operational observations are reported. (auth)

9471 ENERGY 70, PROCEEDINGS. Intersociety Energy Conversion Engineering Conference, Las Vegas, Nevada, September 21–25, 1970. Volume 2. Hinsdale, Ill.; American Nuclear Society (1970). 441p. (CONF-700912-(Vol.2)).

Sixty-six papers were presented. A separate abstract was prepared for each of 48. The remaining 18 papers dealing with nonnuclear power systems, mainly solar and chemical batteries for space power systems and propulsion systems for transportation vehicles were not within the scope of NSA. Critiques and summaries of the conference papers presented are included in this issue. (L.C.L.)

For abstracts of individual papers see: 9472–9502, 9803, 11269, 11433, and 11486–11499.

9472 INTEGRATION OF LARGE ELECTRICAL SPACE POWER SYSTEMS. Hayden, J. H.; Kirpich, A. (General Electric Co., Philadelphia). pp 12.10-14 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Space station concepts presently being considered will consume 25 to 50 kilowatts of electrical power. It appears likely that solar arrays and batteries will provide power initially. As nuclear power plant forms become available, they will be combined with the solar/battery to provide increased power as the station evolves to a larger base configuration. Within this framework of system growth it seems evident that the initial selection of power system characteristics will have long term implications, in that any subsequent changes will be difficult to bring about during later station expansions or modifications. Methods for combining solar/battery power plants with nuclear power plant configurations are considered. The selection of a combining technique has broad implications on the basic form(s) of distributed power to the loads, on the degree of sharing among the various power sources used, and many other system oriented questions. The importance of early study of these factors is discussed. (auth)

9473 SPACE SHUTTLE ORBITER POWER SYSTEM REQUIREMENTS AND DESIGN. Lombard, J. W. (Sperry Rand Space Support Div., Huntsville, AL). pp 12.67-70 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Space station-shuttle power systems are discussed. The power requirements of the orbiter and a trade off study of several possible power system concepts are presented. The power sources considered are fuel cells, solar array/battery, radioisotope Brayton, and cryogenic fueled turboalternators. A fuel cell power source is chosen as the best candidate for the orbiter power system. A baseline power system is defined using four fuel cells, secondary batteries, primary emergency batteries and constant speed drive-alternator units for ferrying power. A weight and cost summary is included. (auth)

9474 DESIGN AND PERFORMANCE OF THE TACSAT POWER SUBSYSTEM. Levy, E. Jr. (Hughes Aircraft Co., El Segundo, CA). pp 13.1-9 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The TACSAT power subsystem consists of two 375 watt cylindrical solar panels, three 28 cell 6 amp-hr nickel cadmium batteries, and 23 electronic control assemblies. It has been in operation since February 1969. Telemetry on board the satellite is available to compare in-orbit to predicted performance. The TACSAT power subsystem configuration is described and the predicted performance compared with the actual performance data received from the satellite. A unique method of solar panel performance measurement used for the first time on this program is also described. Predicted panel output based on this measurement technique will be compared to actual in-orbit panel output. (auth)

9475 SNAP-27/ALSEP POWER SUBSYSTEM USED IN THE APOLLO PROGRAM. Remini, W. C.; Grayson, J. H. (Manned Spacecraft Center, Houston, TX). pp 13.10-15 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The Apollo Lunar Surface Experiments Package (ALSEP) electrical power subsystem is described. Major components are described, programmatic and technical interfaces are discussed briefly, and operational data are presented for the period from November 19, 1969, to April 1, 1970, which includes several lunar-day and lunar-night cycles. (auth)

9476 GERMAN SPACE POWER TECHNOLOGY PROGRAM. Loesch, H. R. (Gesellschaft fuer Weltraumforschung mbH, Godesberg, Ger.). pp 13.32-4 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Support of three major fields was stressed: These include solar cell development in which a solar electric propulsion module is in the project definition phase; development of in-core thermionic reactor (ITR). A terrestrial prototype reactor will go into construction this year; and research on liquid metal magnetohydrodynamics (MHD). A liquid metal loop with a maximum temperature of 900°C and a thermal power of 1.2 MW has been built. The state of the art, the budget, and future activities in the German space power program are discussed. (auth)

9477 NAVY THERMIONIC PROGRAM. Satkowski, J. A.; Roberts, R. (Office of Naval Research, Arlington, VA). pp 14.5-10 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The Navy's program in thermionic converter technology, with the exception of the related materials research, has been directed toward a physical understanding of the thermionic energy conversion process. This research can be divided into two general categories: surface and volume. To a large extent, the surface effects control the electron emission and the contact potential, and the volume effects control the electron transport phenomena. Without exception, these effects cannot be considered independently. It has, thus, been the objective to consider the problem of thermionics as an interrelated problem, the solution of which can be obtained through independent support of key individuals and ideas. The Navy has made significant progress in thermionic research areas which include electrode phenomena, plasma kinetics, atomic physics, sheath phenomena, materials, and modeling. The Navy's support of this research, is reviewed collectively, in order to provide a historical perspective and a view toward the possible impact of basic thermionic research on future engineering designs. (auth)

9478 DEVELOPMENT OF A PLUTONIUM-FUELED MINIATURE POWER SUPPLY BASED ON THERMIONIC CONVER-

SION. Gasper, K. A. (McDonnell Douglas Corp., Richland, WA). pp 14.40-4 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Recently a miniature nuclear battery based on thermionic conversion and utilizing a $^{238}PuO_2$ heat source has been developed. This power supply consists of a relatively low-temperature thermionic diode operating in the vacuum mode and contained within a thermal housing to make the thermal characteristics of the device compatible with the environment of the application. The thermionic diode is coupled electrically with a dc-dc converter to amplify the fractional-volt output of the power cell to the desired voltage level. During this recent development effort, comprehensive analysis and design optimization, the establishment of manufacturing process parameters, and safety development testing were accomplished. Over 20 devices of this type have been fabricated with up to 4.8 mW output from a power cell utilizing 1.3 W(t) of fuel inventory, and 2.7 mW output from a power cell utilizing 0.9 W(t) of fuel inventory. Nuclear batteries of this type will find utility for such remote or long-life applications as spacecraft and marine power sources, power supplies for animal or in-vivo telemetry experiments, or, in the case of lower power units, powering implanted cardiac pacemakers. (auth)

9479 MULTI-HUNDRED WATT CONVERTER DESIGN CONSIDERATIONS. Hemler, R. J.; Kelly, C. E.; Haley, V. F. (General Electric Co., Valley Forge, PA). pp 15.1-7 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The U. S. Atomic Energy Commission has initiated the design and development of a new space power system, identified as the Multi-Hundred Watt Radioisotope Thermoelectric Generator (MHW-RTG). The objective of the MHW-RTG program is to develop a highly efficient, light weight, long-life, plutonium-fueled system for use on a number of potential using agencies' space missions. A discription is given of the evolution of the converter/RTG trade off studies which have been performed to define an optimized converter with an electrical output between 100 and 200W which shall be the basic building block for space power systems with requirements in the 100 to 1000 W(e) range. Converter materials and configuration trade offs are described along with typical RTG concepts. (auth)

9480 CALCULATED LONG-TERM PERFORMANCE CHARACTERISTICS OF A TYPICAL SILICON-GERMANIUM RTG. Raag, Valvo (Resalab Scientific, Menlo Park, CA). pp 15.8-10 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The long-term changes in the properties of the 63 at.% Si-37 at.% Ge alloy are evaluated in terms of their effect on the performance of a representative plutonium-fueled Radioisotope Thermoelectric Generator (RTG) in operation for a time period of 12 years. Calculated generator power output, load voltage, and temperatures are given as a function of time. The relative contributions of fuel decay and changes of thermoelectric properties of the silicon-germanium alloy to total RTG performance decrease as a function of time are evaluated in detail. (auth)

9481 CHARACTERIZATION OF RTG PERFORMANCE IN BOTH AIR AND VACUUM. Luebbers, S. S. (Resalab Scientific, Menlo Park, CA). pp 15.11-17 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

An analytical model is developed to describe the performance of radioisotope thermoelectric generators (RTG's) in either air or vacuum operation. The model accepts, as input information, the physical sizes and thermal properties of the individual generator components. In air operation, as might be encountered on the launch pad, modified heat transfer rates, both internal and external to the RTG, are fully taken into account including the additional mechanism of convection. The utility of the model is demonstrated by using it to characterize the performance and temperature of the Multi-Hundred Watt (MHW) RTG in both air and vacuum operation. (auth)

9482 STATUS OF SILICON GERMANIUM AIR-VAC CONVERTER DEVELOPMENT. Berlin, R. E.; Nelson, R. S. (RCA Electronic Components, Harrison, NJ). pp 15.18-20 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The development of thermoelectric converters incorporating Ge-Si air-vac thermocouples is reviewed with discussion of the design and performance testing of 5-, 7-, 25-, and 40-W(e) converters. The technology which has been validated by testing these converters, particularly the technology associated with the 40-W(e) converter development, provides the basis for future multihundred-watt converter development. The current status of the technology projects the use of the 80% silicon SiGe as the thermoelectric material; multilayered foil thermal insulation; and a design hot shoe temperature of 1100°C. Work is continuing to improve the performance of each of these features and to improve the performance efficiency of the larger, higher power units. (L.C.L.)

9483 DETAILED MATHEMATICAL MODELS OF A RADIOISOTOPE THERMOELECTRIC GENERATOR. deWinter, F. (Jet Propulsion Lab., Pasadena, CA); Raag, V. pp 15.21-5 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Two new models for the design and performance analysis of RTG's are outlined. The first model assumes a small-signal transient-type calculational sequence that permits the separation of steady-state operation of the generator from its dynamic behavior. The second model uses a numerical (finite difference) solution of the performance equations of the RTG. Both models enable the investigation of transient and steady-state performance of RTG's. Simplifying assumptions have been kept to a minimum in the new RTG models and these models enable the inclusion of generator end losses, axial temperature gradients and heat interchange between thermoelements and thermal insulation in RTG performance calculations in a self-consistent manner. (auth)

9484 APPLICATION OF ISOTEC THERMOELECTRIC TECHNOLOGY. Bradshaw, G. B.; Steeger, E. J. (Gulf General Atomic Inc., San Diego, CA). pp 15.26-30 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Lightweight thermoelectric generator technology developed under the Isotec Program is being applied to the TRANSIT RTG. Preliminary specifications for the PbTe generator were based on performance of the ten-panel GC04 demonstration converter, which produced 30.6 watts at 4.82% efficiency. GC04 performance and life-test data are presented, and the application of module and panel data to predicting generator performance after 5 years in space is discussed. The TRANSIT RTG, which is designed to deliver 30 W(e) after 5 years, employs 12 Isotec panels in a prism 23 in. across and 17 in. high. Major TRANSIT converter development testing to date has included a structural test model (STM) and an engineering test model (ETM) used for electrical and thermal performance characterization. During acceptance testing, the ETM converter delivered 37.2 W at a corrected efficiency of 4.85%, based on the flight configuration. Advanced studies have considered use of Isotec PbTe as the cold stage of a cascaded RTG. Cascaded system performance based on existing Isotec and predicted SiGe technology are summarized. (auth)

9485 REPORT ON THE PROPERTIES AND PERFORMANCE OF TAGS. McGrew, J. W. (Teledyne Isotopes, Baltimore). pp 15.31-3 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The properties and performance of the thermoelectric material called TAGS are summarized. The Seebeck coefficient, electrical resistivity, thermal conductivity and figure-of-merit-temperature product are presented. The latter parameter indicates that TAGS is the most efficient p-type material for converting thermal energy to electricity in its temperature range of operation. The thermoelectric parameters, α, ρ, and κ, change with time but an estimate of the changes indicates that they are compensating. Two possible explanations for the changes are suggested. The as-cast structure of TAGS is not homogenous, at least four phases are present. The results of electron microprobe analysis are presented. TAGS undergoes two phase changes, one at about 215°C

and the other at about 520°C. The energy transfer is very small and the lattice constant is changed very slightly. The mechanical properties of TAGS are superior to the lead telluride p-type formulations as determined by a series of simple laboratory tests. The TAGS-2N couples in the SNAP 19 generator have resulted in a generator of 6.3 to 6.5% efficiency, depending on fuel inventory and hot junction temperatures. (auth)

9486 VAPORIZATION CHARACTERISTICS OF $(GeTe)_{0.85}(AgSbTe_2)_{0.15}$ (TAGS ALLOYS. Elsner, N. B.; Selleck, E. G.; Staley, H. G. (Gulf General Atomic Inc., San Diego, CA). pp 15.34-40 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The thermoelectric material $(GeTe)_{0.85}(AgSbTe_2)_{0.15}$ was investigated with respect to its high vacuum behavior at 400°C to 525°C. The results show that the alloy does not vaporize congruently (as does, e.g., PbTe), and the matrix of the alloy is serously influenced by the vaporization. The principal vaporizing species are GeTe, Te_2, Sb_4, $GeTe_2$, and SbTe. Different methods of suppressing vaporization of TAGS have been studied, and it has been shown that both baffling and alloy additions greatly reduce vaporization. (auth)

9487 APPLICATION OF MULTI-LAYER VACUUM INSULATIONS IN HIGH TEMPERATURE SYSTEMS. Notaro, F.; Grunert, W. E. (Union Carbide Corp., Tonawanda, NY). pp 15.51-6 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The high thermal insulating efficiency of multi-foil and opacified fibrous multi-layer insulation systems is widely recognized. Because of their low conductance, these insulations are potential candidates for application to radioisotope-powered systems and, particularly, to thermoelectric converters. Mean effective thermal conductivities (K_a) of the basic multifoil insulations range from 0.08×10^{-3} to 6.0×10^{-3} Btu/hr-ft-°F; K_a for the opacified fibrous filler materials ranges from 0.6×10^{-3} to 10.0×10^{-3} Btu/hr-ft-°F. These K_a values apply to systems operating in vacuum, at maximum service temperature, and under mechanical (compressive) loading ranging from 0 to 15 psi. Thermal conductivity correlations to temperature and layer density (compressive load), developed from the experimental K_a data, are presented and discussed. Use of these basic data and correlations in design of thermal insulation systems is outlined. Application of multilayer insulations to specific thermoelectric converter designs is described, and estimated thermal performance data are presented. (auth)

9488 DEVELOPMENT OF SiGe–PbTe SEGMENTED THERMOELECTRIC COUPLES INVOLVING PRESSURE-CONTACTED JUNCTIONS. Eggers, P. E. (Battelle Memorial Inst., Columbus, OH); Mueller, J. J.; Fry, J. F. pp 15.57-62 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2)

A new concept for the design of segmented thermoelectric couples has been successfully developed which eliminates the need for complicated transition members usually required at the interface of materials possessing greatly differing magnitudes of thermal expansion at the hot and cold ends of the thermoelectric couple. A description of the segmented couple fabrication technique, the results of conversion efficiency measurements, and also a description of a novel technique for the application of the axial loading pressure while maintaining a high thermal conductance and the high degree of flexibility required to insure good electrical contact are presented. (auth)

9489 HYBRID THERMOCOUPLE DEVELOPMENT PROGRAM: A STATUS REPORT. Bifano, W. J. (Lewis Research Center, Cleveland); Garvey, L. P.; Straight, R. A. pp 15.63-70 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The description and development status of a hybrid thermocouple, which employs both PbTe and SiGe thermoelectric materials, is presented. Hybrid couple performance is predicted by means of an analytical model and beginning-of-life couple efficiency is compared to that of an all SiGe couple. A preliminary design of a planar RTG, employing Hybrid couples and a water heat pipe radiator, is described as an example of a possible power system application. (auth)

9490 DESIGN OF SEGMENTED COUPLE TESTING MODULES. Mermelstein, S. (Tyco Labs., Inc., Waltham, MA). pp 15.71-5 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Detailed design studies were directed at creating functional testing packaging for fragile SiGe/PbTe segmented thermoelectrics. The hardware that was ultimately developed consists of submodules that house individual couples and provide all of the necessary external and internal features. These features include a radiant or conduction heat receptor (hot shoe), a heat sink mounting means (cold shoe), total electrical couple insulation, pluggable (intermodule) power output leads, heat shunt path insulation, and pressure contacting for thermal and electrical conduction at low loss. Such submodules can be combined into a module of any regular shape and "any" desired power output using only simple fastenings and basic tools. (auth)

9491 SNAP-19 RADIOISOTOPIC THERMOELECTRIC GENERATOR EXPERIMENT: FLIGHT PERFORMANCE ON THE NIMBUS III OBSERVATORY. Fihelly, A. W. (Goddard Space Flight Center, Greenbelt, MD); Baxter, C. F.; Lyon, W. C. pp 15.84-90 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The Nimbus III/SNAP-19 launch on 14 April 1969 represented the first flight of a nuclear power supply on a NASA observatory. The SNAP-19 nuclear power supply consists of two generators, two DC-DC converters, and a telemetry signal conditioning unit (TSCU). Power is produced by converting the heat of decay of the radionuclide ^{238}Pu in a static thermopile consisting of 90 2n–3p PbTe couples per generator. SNAP-19 S/N 009 produced 49.20 watts of usable power at launch and has degraded to 40.44 watts after a little over thirteen months, which represents a higher than anticipated degradation rate based on testing prior to launch of the same thermopile technology in electrically heated generators and module boxes. Leakage of generator fill gas has resulted in a pressure drop from 15.5 psia soon after launch to an indicated (–)1.00 psia since early January 1970. Generator output currents have decreased as generator internal resistances have increased with time. Hot/cold junction temperatures have increased by about 8 to 10°F during this period, but now appear to be leveling out, while fin root temperatures have risen 3 to 5°F during this period and are also manifesting a leveling trend at the present time. The long-term trend of power output vs. time for further reductions in fill gas pressure will be discussed, as will NASA/AEC analyses and findings regarding the orbital phenomena. (auth)

9492 LONG TERM PERFORMANCE CHARACTERISTICS OF A SNAP-19 GENERATOR OPERATING UNDER VACUUM CONDITIONS. Rouklove, P.; Truscello, V. (California Inst. of Tech., Pasadena). pp 15.91-7 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The results observed during 21,000 hours of parametric and endurance testing of a SNAP-19 thermoelectric generator, SN-20, are presented. This generator was similar to two other generators, SN-24 and SN-25, presently flying in space on the Nimbus III observatory spacecraft launched April 14, 1969. Generator SN-20, with an initial power output of 31 watts at an input power of 630 watts, was operated for most of the time in vacuum at an output voltage of 2.6 volts. A decrease in output power from the initial value to about 26 watts was observed at an average rate of 0.238 W/1000 h. A decrease in pressure and an increase in open circuit voltage and internal resistance of the generator were also noticed. The decrease in output power observed on the electrically heated unit, however, was less than that observed on both Nimbus units. A theory which accounts for this difference is presented. (auth)

9493 PRELIMINARY TESTING OF A SNAP-19 TAGS RTG IN SUPPORT OF THE PIONEER F AND G MISSIONS. Stapfer, G. (Jet Propulsion Lab., Pasadena, CA). pp 15.98-102 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The results are presented of a preliminary performance evaluation of the SNAP-19 TAGS thermoelectric generator which was

selected as the power source for the Pioneer Space Flight Mission. The performance of the SNAP-19 generator was evaluated at various input powers and fin-root temperatures. Results of this evaluation are analyzed and discussed. Tests were also performed to provide the Pioneer Flight Project Management with applicable data such as generator thermal dynamic behavior during launch and prior to deployment. These special tests measure generator performance as a function of fin-root temperature and the dynamic frequency response of the generator. (auth)

9494 SNAP-29 POWER SYSTEM/AGENA INTEGRATION STUDY. Elms, R. V. Jr. (Lockheed Missiles and Space Co., Sunnyvale, CA). pp 15.103-10 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Results are presented of a study performed to: evaluate the feasibility of integrating a SNAP-29 Power System with an Agena satellite vehicle; develop preferred integration configurations; and provide integrated system design requirements. A survey of present and projected Agena missions was made to generate a composite set of representative requirements. Low-altitude orbits were investigated to determine potential advantages of the SNAP-29/Agena configuration. An integrated solar cell power system was compared with the integrated SNAP-29 system in respect to weight, reliability, power conditioning requirements, drag make-up propulsion, and attitude control gas requirements. A SNAP-29/Agena power conditioning concept and design requirements for thermodynamic, dynamic, and nondynamic environments, EMI, and reliability were developed. Major conclusions based on present operational, low-altitude Agena satellite missions are that no significant compatibility problems exist for integration of the SNAP-29 system with the Agena, that atmospheric drag for solar arrays in special array orientations will be comparable to RTG systems and that application of the SNAP-29 RTG rather than solar arrays may be dictated by particular mission constraints not included in this study; e.g., earth-viewing missions in which solar torques become a significant factor in pointing accuracy and vehicle stability. (auth)

9495 TRANSIT RTG: A STATUS REPORT. Lurie, H.; Rocklin, S. (TRW Systems Group, Redondo Beach, CA). pp 15.111-16 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The first five-year-lifetime radioisotope thermoelectric generator (RTG) is being developed for the Navy's Transit Navigational Satellite. The RTG is designed to produce 30 watts end-of-life power and will utilize a light-weight, lead telluride thermoelectric converter that provides in excess of 30 watts per pound beginning-of-life power exclusive of the heat source. Since the hot-side thermoelectric temperature is relatively low (~400°C) the converter does not require hermetic sealing, thereby providing increased reliability over higher-temperature systems which require maintenance of an inert cover gas to inhibit thermoelectric material sublimation. The RTG heat source is designed to provide both intact reentry and intact impact capability and is of all-refractory construction. In addition, the ^{238}Pu dioxide fuel will be in the form of a solid solution cermet which is expected to have added safety advantages over the previously used plutonium dioxide microspheres. An extensive test program on the converter and heat source is currently underway verifying the design parameters and demonstrating the ability of the RTG to meet the program objectives. The present status of the program is described. (auth)

9496 POWER SOURCE CONSIDERATIONS FOR GRAND TOUR MISSIONS. Merrill, O. S. (Jet Propulsion Lab., Pasadena, CA); Weber, W. B.; Leonard, W. D. pp 15.117-25 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Grand Tour missions to Jupiter, Saturn, Uranus, Neptune, and Pluto, for which launch windows will exist in the 1976 to 1979 time period, will require a solar-independent power source capable of providing approximately 500 W of unconditioned power over mission lifetimes of up to 12 years. The only known power source which offers the possibility of meeting these requirements, in this time period, is a Radioisotope Thermoelectric Generator (RTG). Since the SNAP-19 and SNAP-27 will not satisfy the stringent requirements of these missions, the Multi-Hundred Watt (MHW) RTG is currently being developed by the Atomic Energy Commission in response to the expressed needs of the Grand Tour and other potential missions. The mission- and spacecraft-imposed requirements that such a power source must meet are considered and the problems of RTG/spacecraft integration, safety and operations discussed. (auth)

9497 MID-TEMPERATURE MODULES FOR THERMOGENERATORS. Dmitrenko, V. E.; Kolomoetz, N. V.; Lidorenko, N. S. (State Committee of Science and Technique, Moscow). pp 15.126-31 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The development of mid-temperature, i.e., 300 to 700°C working temperature range, thermoelectric space power systems using reactor or radioisotope heat sources is discussed. Information is included on thermoelectric material selection, battery-module performance characteristics, and module testing using an electrical heat source. A mid-temperature module was successfully operated at a hot junction temperature of approximately 650°C for 3000 h. Improved modules with lifetimes in excess of 1 year are envisioned. (L.C.L.)

9498 THERMIONIC POWER SYSTEMS FOR MILITARY FIELD USE. Engdahl, R. E.; Cassano, A. J.; Bedell, J. R. (Energy Research Corp., Bethel, CT). pp 17.11-15 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Since World War II, the military requirements for electrical power have increased nearly seven-fold. At present, each man in the field requires about two kilowatts, including base-site and front-line power. Isolated and front-line systems, in particular, must be portable, reliable, silent and capable of operation with readily available fuels such as gasoline or jet fuel. Studies indicate that thermionic power systems are well matched to these requirements. The main problem area involves the development of a materials system capable of long life in a high-temperature, fossil-fuel environment. Work has progressed to the point at which the materials problems appear to be solved. Using a 100 watt thermionic module configuration, operating lifetimes of 1200 hours have been obtained and system designs based on this module have been developed. The development of thermionic power systems is described and thoughts on the future applicability of thermionics to military purposes are presented. (auth)

9499 ENERGY AND THE ENVIRONMENT IN ELECTRIC POWER GENERATION. Gerber, Abraham (National Economic Research Associates, Inc., New York). pp 18.1-4 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From 5th annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Environmental problems connected with electric power generation are discussed by considering: the growth of electric power production and use in the U. S.; the environmental effects of increased generating capacity using fossil or nuclear fuels; the higher cost of electric power generation resulting from the need to control environmental impacts; the future developments, such as MHD technology and cryogenic transmission, which may provide the means for partially offsetting the high cost that environmental controls will impose on electric power supply. (L.C.L.)

9500 MHD POWER GENERATION FOR CENTRAL STATION APPLICATION. Kantrowitz, A. R.; Rosa, R. J. (Avco Everett Research Lab., Everett, MA). pp 18.8-15 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The status of combustion-driven MHD generator technology is reviewed from the viewpoint of electric utility applications and its prospects for utilization are discussed. Both base load and emergency or peaking systems are considered. In the case of base load stations, MHD systems reach substantially higher overall thermal efficiencies than those attainable with conventional methods together with greatly reduced pollution of both air and water. For emergency or peaking power, MHD offers a relatively simple power system with the capability of delivering full rated power from a cold start in a few seconds. System design studies, economic estimates and pollution control aspects are presented. The overall benefits offered by these MHD generator systems warrant

the further development required for their commercial realization and a program to achieve this goal is outlined. (auth)

9501 HIGH TEMPERATURE POWER GENERATION. Louis, J. F. (Massachusetts Inst. of Tech., Cambridge). pp 18.18-23 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

A review of the high temperature technology associated with the Brayton cycle for large central power stations strongly suggests that important gains in efficiency and reduction of thermal pollution could be made with the introduction of high temperature reactors. For the nuclear cycle, low fuel costs can be expected due to high burn up rates and high efficiency. The use of closed cycles working at high pressure is also expected to reduce the capital expenditures. For the open cycle, MHD power generation shows promise of high efficiency in the very large sizes which the gas and stream turbines cannot handle easily. The combination of Brayton and Rankine cycles provides a good route to achieve this goal from the points of view of efficiency, reliability and possibly cost. (auth)

9502 CENTRAL STATION RELIABILITY NOW AND IN THE FUTURE. Tillinghast, John. pp 18.27-33 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Factors which affect the reliability of utility companies in supplying an adequate and continuing supply of electricity to their customers are reviewed and include adequacy of fuel supply, availability of generating and transmission equipment, and attitudes of corporate management. It is concluded that the electric power industry has a fundamental and overriding obligation to supply instantaneously and adequately its service to its customers. To discharge this responsibility it must adequately provide for raw energy sources; coal, gas, oil or nuclear. It must engage in adequate planning and construction programs to erect strong high voltage transmission systems supported by continuing research and development. Most importantly, from the point of view of this paper, it must exert every effort on new generating stations to reverse a current downward trend in availability of the new, larger units which must be built to keep step with load growth and to achieve the economies of larger scale. Availability must be improved by better engineering in the planning, plant design and equipment design stages; better production control and testing in the manufacturers' facilities; better quality control in field erection and installation; and better operating techniques of the final installation. If these efforts are successfully mounted, there is every reason to expect that the new, larger units of the future can achieve satisfactory levels of availability, and, if supported by adequate fuel and transmission programs, can make their full contribution to a satisfactory level of reliability in the overall supply of electric energy to our economy. (auth)

9503 HOT CERAMIC ELECTRODES FOR OPEN-CYCLE MHD POWER GENERATION. Meadowcroft, D. B.; Meier, P. G.; Warren, A. C. (Central Electricity Research Labs., Leatherhead, Eng.). Energy Convers.; 12: No. 4, 145-7(Dec 1972).

Three materials were tested as hot MHD electrodes under generating conditions. The materials were castable calcia-stabilized zirconia, 50 mol percent ceria-zirconia, and strontium-doped lanthanum chromite. After 106 min of running time the ceria-zirconia electrodes were badly eroded, the calcia-stabilized zirconia had shown itself to be useful electrode material, and the lanthanum chromite electrodes were scarcely damaged. It is concluded that strontium-doped lanthanum chromite should be given much further attention as a hot MHD electrode with a front face temperature up to 1600 to 1700°C. (auth)

9504 SOCIAL ORGANIZATION OF ELECTRIC POWER SUPPLY IN MODERN SOCIETIES. Sporn, P. Cambridge, MD; Massachusetts Institute of Technology Press (1971). 154p. $6.95.

Four lectures given at the Massachusetts Institute of Technology during 1970 and 1971 on private vs. public ownership of electric power companies are presented and include information on electric power generation in the U. S. and other advanced countries; ideological considerations involved in the merits of private vs. public power; technical competence and performance as influenced by social organization; protecting the consumer and the public interest; and future problems of electric energy supply systems with possible developments in the U.S. for solving these problems. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 9464 and 9793.

9505 (UJV-2868-M-A) HIGH TEMPERATURE EMF SOLID ELECTROLYTE DEVICE FOR THERMODYNAMIC AND TRANSPORT PROPERTY MEASUREMENTS OF NUCLEAR CERAMIC FUELS. Jakes, D.; Skvor, F.; Dana, J.; Nykl, L. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 47p. (In Czech). Dep. NTIS (U. S. Sales Only).

The theoretical basis is explored to derive design requirements for the solid electrolyte emf device designated for thermodynamic and transport properties measurement. Thermodynamic measurements in the field of oxygen solubility in metals as well as non-stoichiometry in oxides, fluorides, and sulfides are considered. The transport properties theory of an ionic crystal is briefly treated in both aspects—transport of ionic or atomic substance through electrolytes and electrodes. The design requirements are compared with the actual technical execution. (auth)

9506 DISTRIBUTION OF THE MAGNETIC FIELD ALONG THE AXIS OF THE CHANNEL IN THE MAGNETIC SYSTEM OF A CONDUCTING (DC) PUMP. Vitol, V. Kh. Magn. Gidrodin.; No. 1, 137-9(1972). (In Russian).

One of the main requirements concerning the behavior of the magnetic field beyond the boundaries of the polar terminals is a smooth decrease of the transversal component. This decrease was experimentally determined along the axis of a MHD pump. It was found that the height of the polar terminal affects only slightly the distribution of $B^*(x)_\delta$, and in practical calculations, when $a_{p\delta} > 3$, a specific relation derived for the case of $a_{p\delta} = \infty$ should be used. A smooth decrease of the magnetic field requires a slope of $\frac{1}{2}\alpha = 15$ to 20°. The calculated relative gap is a function of the angle of slope. The experimental data indicated that the unlimited pole width in the direction of the perpendicular axis of the channel, assumed in these calculations, leads to excessive errors. (TTT)

9507 PIERRE SUE ACTIVATION ANALYSIS LABORATORY. A JOINT CEA, CNRS PROJECT. Leveque, Pierre (CEN, Fontenay-aux-Roses, France). Energ. Nucl. (Paris); 14: No. 3, 177-9 (1972). (In French).

The purpose of the Pierre Sue facility is to enable research workers and technicians of the CEA, universities, the CNRS, and industry to utilize the irradiation facilities of the nuclear reactors at Saclay. This facility provides 6 laboratories (each 50 m^3). These laboratories are connected to the two nuclear reactors in such a way that samples can be irradiated in one of the reactors and recovered immediately after activation. (France)

9508 GENERAL ELECTRIC'S SPENT FUEL REPROCESSING PLANT. Com. Naz. Energ. Nucl., Notiz.; 18: No. 8-9, 90-5(1972). (In Italian).

A description is given of the plant that General Electric has completed at Morris, Ill. and of the other reprocessing plants planned in the U.S. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 9455, 9468, 9505, 9791, and 11552.

9509 (CEA-CONF-2065) VOID FRACTION, VAPOR, AND LIQUID TEMPERATURES LOCAL MEASUREMENTS IN TWO-PHASE FLOW, USING A MICROTHERMOCOUPLE. Delhaye, J. M.; Semeria, R.; Flamand, J. C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 18p. (CONF-720802-3). Dep. NTIS (U. S. Sales Only).

From 13th national heat transfer conference; Denver, CO. (6 Aug 1972).

A technique is described, which allows the detection of the phase (liquid or vapor) on the hot junction of a microthermocouple and the measurement of the temperature of each phase in steam–water two-phase flow. The signals are processed with a multichannel analyzer in order to obtain the amplitude histograms of the temperature. Significant results are obtained in pool boiling, forced convection, subcooled boiling, and flashing flow. (auth)

9510 (KFK-1642) INVESTIGATION OF THE TURBULENCE AND SHEAR STRESS IN A CIRCULAR CHANNEL WITH A HOT WIRE ANEMOMETER. Rehme, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jul 1972. 41p. (In German). Dep. NTIS (U. S. Sales Only).

A test was performed in a circular channel on the use of a DISA hot wire anemometer for the experimental investigation of shear stress and turbulence of turbulent flow. For circu-

lar tubes the shear stress distribution can be obtained theoretically. A number of papers can be found in the literature communicating the measurements of turbulence intensities. For the evaluation of the data a method developed by B. Kjellstrom is adopted. The measurements were conducted for Reynolds numbers ranging between 2×10^4 and 2×10^5 at a position of 75 tube diameters. The experimental results of the shear stress distribution are in excellent agreement with the theoretical values; the experimental turbulence intensities are in very good agreement with the data published in the literature. (auth)

9511 (ORNL–4808) HEAT TRANSFER IN A GAS-COOLED, HEAT-GENERATING POROUS SOLID. Rannie, R. P. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 140p. Dep. NTIS.

Thesis. Submitted to Pennsylvania State Univ., University Park.

A study was conducted to determine if an experimental apparatus can be built for use in gas phase chemical reactions in electrically heated porous tungsten and for use in measuring the heat transfer coefficient in the porous tungsten using nitrogen or helium gas as the coolant. The extent of the alleged similarity between the temperature of the solid and the fluid can thus be determined. It was proposed that the equations for heat transfer in a fluid cooled, heat generating porous solid be derived and used to analyze data from experimental measurements on the porous system. These equations were not to be based on or be restricted by the assumption of the essential equality of the solid and fluid temperature in the porous material. Appropriate experimental measurements were carried out in order to measure four boundary conditions from which the three constants of the equations and the heat transfer coefficient can be determined. The equations were derived and incorporated into FORTRAN digital computer programs that were used to accomplish the data reduction. The experimental apparatus was built and operated in spite of extensive developmental problems associated with electrical contact resistance at the mounts of the porous tungsten. Owing to the lack of data on the effective thermal conductivity of the porous tungsten, a fifth boundary condition was measured from which a conduction correction factor was determined for the porous tungsten. The heat transfer coefficients that were measured show good agreement with other experimental measurements of heat transfer coefficients. Correlations which had been suggested for heat transfer coefficients and which were not generally based on experimental data gave heat transfer coefficients that were larger than measured values by two or three orders of magnitude. The assumption of such large heat transfer coefficients could continue to support the idea that the temperature of the solid and fluid are nearly identical. Even at Reynolds number 10^{-1}, solid and fluid temperature differences of hundreds of degrees F were observed. (auth)

9512 (ZJE–115) ANALYTIC SOLUTION OF FLOW AND HEAT TRANSFER IN SMOOTH AND FINNED RODS ARRAYS WITH AXIAL FLOW. Krett, V. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 42p. Dep. NTIS (U. S. Sales Only).

An analytic solution of flow and heat transfer in both triangular and rectangular arrays of smooth rods with axial flow is given. The method used is discussed for the case of finned rods. The eddy diffusivity coefficient along the perimeter has been calculated from the integral-differential equation by the use of experimental formulas for shear stress on the rod surface. This coefficient is further used for the calculation of temperature fields and heat transfer coefficients. At the same time the velocity distribution in cross section of cells is calculated by means of Reichardt universal velocity formula. (auth)

9513 EFFECT OF ENTRANCE CONFIGURATION ON LOCAL HEAT-TRANSFER COEFFICIENTS IN SUBSONIC DIFFUSERS. Stoffel, E. O. (California Polytechnic State Univ., San Luis Obispo); Welty, J. R. J. Heat Transfer; 94: No. 4, 355–9(Nov 1972).

The effects of square and reentrant entrances on flow regimes (no appreciable separation, large transitory stall, and fully developed two-dimensional stall) and local heat-transfer coefficients were determined with air flowing through a symmetrical, plane-wall, two-dimensional subsonic diffuser with one of the diverging walls heated and maintained isothermally. Flow and heat-transfer studies were made for the following ranges: $2\theta = 0$ to 45°, $L/W = 6$ to 18, and $Re_{xtut} = 4 \times 10^4$ to 3×10^5. Results indicated that 2θ, L/W, and entrance configuration greatly affected the flow regime and heat transfer. Equations relating U_m to U_t, U_r to U_t, and equations of the type $Nu = C\ Pr^{0.6}\ Re_x^{0.8}$ are presented. For the configurations tested, heat-transfer rates were greater for reentrant than for square entrances. (auth)

9514 TRANSIENT FREE CONVECTION IN A BINGHAM PLASTIC ON A VERTICAL FLAT PLATE. Kleppe, J.; Marner, W. J. (South Dakota School of Mines and Tech., Rapid City). J. Heat Transfer; 94: No. 4, 371–6(Nov 1972).

A theoretical investigation of transient free convection in a Bingham plastic on a vertical flat plate with constant wall temperature is presented. Except for a linear variation of density with temperature in the body force term, all fluid properties are assumed to be constants. The parameters of the problem are the Prandtl number Pr and a dimensionless group involving the Hedstrom and Grashof numbers, $He/Gr_L^{\frac{1}{2}}$. Solutions to the governing boundary-layer equations are obtained using an explicit finite-difference procedure. Mean Nusselt numbers Nu_L are presented for a range of the parameters, along with representative velocity profiles, temperature profiles, and friction coefficients. Flow in the Bingham plastic does not start until the buoyancy forces become sufficiently large to cause a shear stress in the material which exceeds the yield stress. Thus, for short times heat is transferred by one-dimensional transient conduction, which has the well-known solution expressed in terms of the complementary error function. A temporal minimum, which becomes more pronounced with increasing $He/Gr_L^{\frac{1}{2}}$, is noted in the mean Nusselt number. Steady-state Nu_L values are higher for Bingham plastics than for Newtonian fluids, but the maximum increase, which decreases with increasing Pr, is noted to be less than 15 percent. Due to the behavior of the velocity gradient at the wall, which reaches a maximum before steady-state conditions are reached, a temporal maximum is observed in the mean friction coefficient. Bingham-plastic friction coefficients are significantly higher than for Newtonian fluids; however, this increase is due primarily to the yield stress rather than as a consequence of a steeper velocity gradient at the wall. (auth)

9515 SURFACE-TENSION EFFECTS IN BOILING FROM A DOWNWARD-FACING SURFACE. Huplik, V. (NHKG Research Inst., Ostrava, Czech.).; Raithby, G. D. J. Heat Transfer; 94: No. 4, 403–9(Nov 1972).

An experimental investigation of the effect of surface-tension variation around air and vapor bubbles on a downward-facing heated surface is reported. For air bubbles, and vapor bubbles at moderate heat fluxes, regimes of flow where surface-tension forces and buoyancy forces respectively dominate, are defined. For boiling at heat fluxes near the burnout limit, flow driven by surface-tension forces appears to play a large role in cooling the heated surface. It is shown that small amounts of surfactant added to the liquid result in dramatic changes in the boiling mechanism, and at high heat fluxes a substantial improvement in the heat transfer. Most of the experiments were conducted with the liquid at temperatures less than the saturation temperature. (auth)

9516 LOCAL FORCED CONVECTION BOILING HEAT TRANSFER OF WETTING MERCURY IN A SINGLE TUBE WITH VORTEX INSERT. Hsia, E. S. (General Electric Co., Cincinnati). pp 7.61-5 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Local heat transfer data and empirical correlations for boiling mercury in a single wetted tantalum tube with composite helical inserts are presented. The well-instrumented test section, which is in the shell-and-tube type heat exchanger, contains a static NaK layer in an annulus between the primary NaK flow and the secondary mercury flow to protect the tantalum test tube. Experimental heat transfer data for individual heat transfer regions in the once-through boiling process were obtained over the following ranges: saturation temperature 975 to 1120°F, mercury mass velocity 81.5 lb/sec-ft^2 to 192 lb/sec-ft^2, Reynolds number 0.875×10^4 to 2.18×10^4 and degree of superheat at the tube exit 205 to 400°F. (auth)

9517 FOURTEENTH CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH. VOLUME 1, HYDRAULIC RESEARCH AND ITS IMPACT ON THE ENVIRONMENT. Conference Held at Paris, France, August 29, 1971. Paris; Societe Hydrotechnique de France (1971). 390p. (In French and English). (CONF-710843-(Vol.1)).

Forty six papers were presented at the conference. The five papers abstracted deal with mixed convection in liquid metal flow and the thermal pollution of water resulting from power station cooling systems. (France)

For abstracts of individual papers see: 9518, 9519, and 9586–9588.

9518 APPROACH METHODS TO THE PROBLEMS OF MIXED CONVECTION IN LIQUID METALS. Daubert, A. (Electricite de France, Chatou); Huffenus, J. P. pp 299-308 of Fourteenth Congress of the International Association for Hy-

draulic Research. Vol. 1. Paris; Societe Hydrotechnique de France (1971). (In French).

From fourteenth congress of the International Association for Hydraulic Research; Paris, France (29 Aug 1971). See CONF-710843-(Vol.1).

The principal difficulties arising in the various approaches to the problem which use reduced scale physical models or mathematical models are demonstrated. Two types of flow are considered: in the presence of the natural convection produced by heat transfer along the walls, and in the absence of such convection. As a general rule, the physical model can only be envisaged for the second type of flow. Difficulties are nevertheless encountered in the practical realization of this model. In problems in which convection along the wall is essential, the physical model is often impossible to use and a mathematical model has to be adopted (certain boundary conditions being determined from the physical model). Some examples illustrating the theory are presented. These examples apply to the intervessel region of the Phenix Reactor. (France)

9519 EXPERIMENTAL STUDY OF MIXED CONVECTION IN CHANNELS. Wendling, M.; Martin, R.; Ricque, R. (CEN, Grenoble, France). pp 309-16 of Fourteenth Congress of the International Association for Hydraulic Research. Vol. 1. Paris; Societe Hydrotechnique de France (1971). (In French).

From fourteenth congress of the International Association for Hydraulic Research; Paris, France (29 Aug 1971). See CONF-710843-(Vol.1).

Experimental results obtained on mixed convection in a channel are presented. The working fluid is Na. Emphasis is given to the qualitative aspects of the phenomena and to the effect of important parameters such as the flow velocity and the canal width. The results obtained for turbulent and laminar flow are compared. (France)

Materials Testing

Refer also to abstracts 9467, 9799, 9991, and 9998.

9520 FRACTURE MECHANICS CHARACTERISTICS OF MATERIALS. Berns, H. (Boehler (Gebr.) and Co. AG, Duesseldorf). Konstr. Masch.-, App.- Geraetebau; 24: No. 3, 86-93(1972). (In German).

A summary is presented of the development, basic principles, purpose, and application of fracture mechanics to the mathematical description of certain fracture processes. It is of essential significance in the determination of fracture-size tolerances and the dimensioning of high-strength construction materials in aeronautics, space flight, reactor technology, and pressure vessel construction. The evaluations are made to obtain reliable data as to the maximum permissible fracture-length for a given stress. A useful application of fracture mechanics is, for the time being restricted to greater wall thickness, low temperatures, or high-strength materials. (GF)

9521 NONDESTRUCTIVE DETECTION OF HYDRIDES AND ALPHA-CASE IN TITANIUM ALLOYS. Hagemaier, D. J. (McDonnell Douglas Corp., Long Beach, CA). Mater. Eval.; 30: No. 12, 268-72(Dec 1972).

At elevated temperatures, titanium and titanium alloys have a strong affinity for the elements hydrogen and oxygen. Hydrides and alpha-case can embrittle titanium alloys and cause cracking. Reliable, inexpensive, nondestructive tests for detecting hydrides and alpha-case in raw materials and parts after pickling, heat treating, welding, and brazing are not commonly known. The object of a nondestructive test is reliably to measure rejectable levels of hydrides and alpha-case in titanium alloys before parts or materials are manufactured or placed in service. Ultrasonic attenuation tests at 5 or 10 MHz are capable of separating the specimens containing 200 or more parts per million in hydrogen content from specimens containing an acceptable hydrogen content of 50 to 150 ppM. Eddy current tests at frequencies of 2 and 6 MHz are capable of determining alpha-case depths of 0.0005 in. (12.5 μm) and greater. Thermoelectric tests do reveal severe hydriding and alpha-case in titanium, but the results are erratic and more qualitative in nature than results obtained by ultrasonic or eddy current tests. (auth)

9522 METHOD OF TESTING ORGANIC MATERIALS. Ruben, N. Y.; Grishin, V. D.; Nikolskii, V. G.; Talroze, V. L.; Tochin, V. A. (to Ordena Lenina Inst.). British Patent 1,285,650. 16 Aug 1972. Filed 20 Nov 1970.

The method described is stated to be suitable for investigating structural transitions in organic substances and can be used, for example, for examining molecular mobility in high- and low-molecular weight substances, for examining the cold resistance and the degree of crystallization of polymers, the mastication and structurization of rubber, and the compatibility of high-molecular weight substances. It has been found that the thermal luminescence method may be carried out using relatively low energy electrons for irradiation and hence a much simpler and less expensive radiation source may be employed than in the conventional method. The organic substance under investigation is cooled, and then irradiated in vacuo with a beam of electrons of energy 1 to 50 keV, followed by heating and measurement of the luminescence intensity. Apparatus for conducting the method is described. (UK)

9523 ACOUSTIC EMISSION MONITORING OF THE FFTF REACTOR FUEL PIN END CLOSURE WELDS. Romrell, D. M. (Hanford Engineering Development Lab., Richland, WA). Mater. Eval.; 30: No. 12, 254-8(Dec 1972).

Acoustic emission is defined as the elastic waves produced in solid materials by an energy release as the material is deformed or fractured. These elastic waves travel through the solid material at the speed of sound and can be detected at the surface with sensitive acoustic emission sensors. This provides a basis for a technique of monitoring metal structures during welding processes to detect the formation of anomalies such as microcracks. On many structures, acoustic emission monitoring can provide both quantitative and flaw location data. Acoustic emission monitoring augments other nondestructive testing methods and is sometimes applicable when other tests cannot be conducted. This is, in part, due to the high sensitivity of acoustic emission monitoring. Acoustic emission monitoring is only sensitive to active flaw growth, however, and will not detect a flaw in equilibrium. The application of acoustic emission monitoring to end closure welds on the Fast Flux Test Facility reactor fuel pins is described, and illustrates the correlation that has been made between destructive metallurgical microscopy of welds and the emissions that were recorded during the welding process. (auth)

Nuclear Explosions

Refer also to abstracts 9566, 9581, and 9582.

9524 (AD-744130) LONG-PERIOD SEISMOLOGICAL RESEARCH PROGRAM. Annual Report, March 15, 1971–March 14, 1972. Sykes, L. R.; Savino, J. M. (Columbia Univ., Palisades, N. Y. Lamont-Doherty Geological Observatory). 4 Apr 1972. Contract F44620-71-C-0082. 34p. (AFOSR-TR-72-1215). NTIS.

During the first year of the subject contract, the purpose of the research program was twofold: To maintain the previously installed high-gain seismograph stations at the following five stations: Charters Towers, Australia (CTA); Fairbanks, Alaska (FBK); Eilat, Israel (EIL); Chiang Mai, Thailand (CHG); and Ogdensburg, New Jersey (OGD), and to install and maintain a sixth high-gain station at Toledo, Spain (TLO) and to conduct research on the long-period analog and digital data from the above six stations and from the two additional stations installed at Albuquerque, New Mexico (ALQ) and Kongsberg, Norway (KON), by personnel from the National Oceanic and Atmospheric Administration (NOAA). The most significant finding of the analysis of data pertinent to the earthquake-explosion discrimination problem is one based on results from the seismic detection, discrimination, earth noise, and digital filtering studies. (auth)

9525 (CEA-CONF-2057) PRACTICAL STUDY OF VIBRATIONS PRODUCED BY FIRING EXPLOSIVES WITH AND WITHOUT PREDECOUPLING. Leandri, M.; Collin, C. R. (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 14p. (In French). (CONF-720575-1). Dep. NTIS (U. S. Sales Only).

From 34th congress on European Association of Exploration Geophysicists; Paris, France (30 May 1972).

The C.E.A. has carried out a study of seismic phenomena, entailed by the use of explosives in order to prevent blasts from causing damage to the slopes of open pit or the side-walls of underground mines. A practical formula was derived, relating particle velocity (U) with distance (d), charge weight (W) and blasting pattern, i.e., $U = K(W^{\gamma}/d^{2})$. The attenuation effect induced by presplitting was calculated from the measurements obtained. Results showed that particle velocities, within a 10 meters zone beyond the presplitting line, are reduced by the following factors: 4 for stopping blasts set within a 30 to 40 m range before the presplitting line; and 6 for blasts close to the presplitting line. However, in both cases, attenuation becomes nil 25 meters beyond the presplitting line. (auth)

9526 (CONF-721108-4) RELATIVE RISKS FROM RADIONUCLIDES FOUND IN NUCLEARLY STIMULATED NATURAL

GAS. Kelly, M. J.; Rohwer, P. S.; Barton, C. J.; Struxness, E. G. (Oak Ridge National Lab., Tenn.). 1972. 27p. Dep. NTIS.
From PNE panel meeting; Vienna, Austria (26 Nov 1972).

The risks from man-made radionuclides possibly present in nuclearly stimulated natural gas are considered in three steps: radionuclides are ranked on the basis of their estimated radiation dose potentials; projected doses expected to result from gas usage are compared with estimated doses from other radiation sources; and risk projections for the estimated doses are compared with other risks encountered in the normal activities of life in technologically developed nations. Information is included on the method for risk calculation, data on the specific radioisotopes in cavity gas from the Rulison Event, radioisotope concentration in gas combustion products, estimates of whole body dose equivalents, and average annual dose to an individual in the U. S. It was estimated that 0.1 deaths per year per million gas users could result from domestic use of nuclearly stimulated natural gas. This compares with an estimated rate of 20 deaths per year per million population from medical diagnostic uses of x rays. (L.C.L.)

9527 (FOA-4-4517-A-1) U. S. NUCLEAR EXPLOSION, HANDLEY, MARCH 26, 1970. Event Report No. 5. (Hagfors Observatory, Stockholm (Sweden)). Nov 1972. 27p. Dep. NTIS (U. S. Sales Only).

Seismic data obtained at the Hagfors Observatory in Sweden from the U. S. Nuclear Explosion Handley of Mar. 26, 1970 are presented, and include the recorded short- and long-period signals, their spectra, and the surface wave dispersion curves. (auth)

9528 (JAB-99-100) NONLINEAR DYNAMIC ANALYSIS OF FRAMES WITH FILLER PANELS. Kost, E. G. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Nov 1972. Contract AT(26-1)-99. 333p. Dep. NTIS.

The presence of filler panels can have a significant effect on the lateral dynamic response of a framed structure. It has been observed in certain cases that the bond between the frame and filler panels has been destroyed by prior motion of the building, poor construction techniques, or similar causes. The results can be gaps between the filler panels and the adjacent beams and columns of the frame. During subsequent response of the structure, such as response to an earthquake or underground nuclear explosion, the structure may displace enough for the frame to contact the panels and thereby close the gaps. Repetitive closing and opening of the gaps may occur during the response of the structure. An analytical model and a computer program were developed to perform nonlinear dynamic analyses of a plane frame with filler panels and gaps between the sides and tops of the panels and the frame. In addition, an analytical model and program were developed for linear elastic analyses of a frame with monolithic panels, that is, with no gaps. The framing members of the structure were represented by conventional line elements in bending with axial deformations, and the filler panels were represented by finite element meshes using the Oakberg-Weaver rectangular plane stress element having 16 nodal displacements. Special elements were developed for panel corners by the use of a coordinate transformation procedure, and static condensation techniques were used to eliminate certain degrees of freedom and thereby reduce the problem size. Modal superposition techniques were used to solve the equations of motion for the linearly elastic case, and the incremental linear acceleration method was used for the nonlinear case. Criteria were developed for the monitoring of the opening and closing of gaps, and a procedure was developed for the modification of the stiffness matrix upon closing and opening of gaps. Linear and nonlinear examples were analyzed to illustrate the application of the techniques and computer programs that were developed, and to illustrate the effects of varying certain parameters in the analyses. It was found that the presence of gaps between the frame and panels can significantly affect the dynamic response of structure. In addition, rather different responses were obtained for gaps of different widths. (auth)

9529 (NVO-746-8) PRELIMINARY SEISMICITY STUDY OF THE SOUTHERN NEVADA REGION FOR THE MONTH OF OCTOBER 1972. Bayer, Kenneth C. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Dec 1972. Contract AT(29-2)-746. 21p. Dep. NTIS.

A cooperative (ESL, Sandia Laboratories, and USGS) network of 21 seismic velocity sensitive stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party located in Las Vegas, Nevada. The Twin Springs and Alamo areas of Nevada plus the upper termination of Death Valley in California (west of Scotty's Junction) were unusually active during the month. Two seismicity maps are included; one of the southern Nevada region and the second of the seismicity on and adjacent to the Nevada Test Site (NTS). This is the fourth in a series of monthly seismic bulletins covering the southern Nevada region, monitored by the Las Vegas, Nevada-based Special Projects Party. The seismic data output is listed in the Hypocenter Summary (Appendix A). The listing is the result of data scaled only from the local cooperative network, and solutions determined by a local-epicenter program. A total of 93 epicenters is listed. (auth)

9530 (NVO-1163-41) ANALOG COMPUTER ANALYSIS OF MAGNETIC TAPE SEISMOGRAMS. Lynch, Robert (Beers (Roland F.), Inc., Alexandria, Va.). 20 Jan 1965. Contract AT(29-2)-1163. 42p. Dep. NTIS.

Analog computer programs for analysis of magnetic tape seismograms recorded by a National NC-21 transducer-L-5 amplifier seismometer system are described. These programs extend the analyzable frequency range by compensating for non-linear transducer response, derive displacement and acceleration from recorded velocity, determine two and three component vector amplitudes, provide amplitude-frequency information by band-pass filtering, and aid in the identification of wave modes. (auth)

9531 (NVO-1163-141) DURATION OF SEISMIC PULSES. Beaudet, P. R.; Lynch, R. D. (Environmental Research Corp., Alexandria, Va.). 18 Jun 1968. Contract AT(29-2)-1163. 19p. Dep. NTIS.

This study was performed to define the concept of signal duration and perform measurements of duration on seismic data. ERC Band-Pass Filter (BPF) studies show that energy in the neighborhood of a given frequency band persists for only a few cycles within the time history of measured seismograms. This effective number of cycles is defined as duration. It is shown that the seismic disturbances caused by underground nuclear detonations at the Nevada Test Site have an equivalent constant duration of about four cycles, independent of frequency. (auth)

9532 (NVO-1163-TM-34) QUESTION OF GROUND MOTION DURATION FOR NUCLEAR DETONATIONS AND EARTHQUAKES. Rogers, A. M. (Environmental Research Corp., Las Vegas, Nev.). Jul 1972. Contract AT(29-2)-1163. 38p. Dep. NTIS.

Previous work related to the duration of earthquake ground motion is reviewed. The PSRV/BPF definition of duration, previously used for a study of ground motions generated by nuclear explosions, was computed for a large sample of earthquake seismograms. It was found that the PSRV/BPF ratio is only slightly dependent on period and epicentral distance and is independent of magnitude. This result disagrees with published results using other definitions where duration was found to be strongly dependent on magnitude and weakly dependent on distance. The mean ratios for earthquakes and nuclear explosions were considered essentially equal, although statistically unequal at the 5% level. The results of this study were considered in terms of the PSRV and BPF response to complex ground motion using several hypothetical examples and analogy with the PSRV response to a random nonstationary model of strong motion accelerograms. It is concluded that for complex ground motion, the PSRV/BPF ratio is not strongly dependent on any one ground motion parameter. It is recommended, therefore, that an alternate definition of duration, measured on the seismogram, be employed to study differences between ground motion from earthquakes and nuclear explosions. (auth)

9533 (PNE-3025) SENSITIVITY ANALYSIS OF THE RELATION OF WELLHEAD PRICE TO NUCLEAR GAS STIMULATION COSTS. Daly, P. A. (Division of Applied Technology (AEC), Washington, D. C.). Aug 1972. 15p. Dep. NTIS.

A cost analysis was made to determine the effect of assumed explosive costs on the wellhead price of nuclearly stimulated natural gas and to determine if this method is cost competitive with other methods for stimulating gas production. The variables considered included the cost per explosive and number of explosives required for deep and moderately deep explosive emplacement. For each case the present worth of future net revenues, discounted at both 10% and 20%, was computed for a high and low production case, and for a range of wellhead gas prices. It was concluded that for the 10% discount case, the nuclear gas stimulation technology could support a wide range of possible explosive costs and still be competitive with alternative technologies. Even with poor fracturing, less gas in place, and poor permeability, the technology could support an explosive cost in the $600,000 to $800,000 range. At a 20% discount rate, an explosive cost exceeding $600,000 would severely limit the use of the technology. (L.C.L.)

9534 (PNE-WW-21) REVIEW OF STRUCTURAL EFFECTS STUDIES FOR PROJECT WAGON WHEEL. Preliminary Report. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Jun 1972. Contract AT(26-1)-99. 35p. Dep. NTIS.

A review of structural effects studies conducted for Project Wagon Wheel, a gas stimulation project planned for the Pinedale area in western Wyoming, is summarized. The methods employed in the analysis for dams, natural slopes, canals, towers, and buildings appeared to be reasonable. Several recommendations regarding structural effects criteria and particular structures are given. The significant recommendations are: the building evacuation criterion should be reevaluated and special consideration should be given to public gathering places such as schools, a perceptible motion notification criterion should be stated, the investigation of dams should be extended to insure that all potentially hazardous dams can withstand motion at least 2σ above the mean prediction levels without significant damage. Otherwise remedial measures should be planned, if bridges are to be braced during the detonation, appropriate analyses should be made to show the effects of the bracing on the bridge structure, the Big Piney water tower should be analyzed including sloshing effects if it is not emptied for the detonation, and the potential for cistern damage should be evaluated. (T.F.D.)

9535 (SC-RR-720342) PROJECT MIDDLE COURSE II AIRBLAST AND SURFACE MOTION. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Dec 1972. 120p. Dep. NTIS.

Airblast measurements made on 28 1-ton HE explosions over a range of burial depths permit description of airblast suppression as a function of burial depth for earth stemming (5 shots), water stemming (5 shots), gravel stemming (1 shot), 36-inch-diameter open holes (7 shots) and a 4-inch-diameter open hole (1 shot). The suppression with burial depth of impulse and energy in the gas-venting pulse of the airblast correlates quite well with the suppression of residual radiation outside craters of nuclear cratering events. Surface displacement-time measured on two shots by photography agreed with displacement-time derived from acceleration-time measurements. Acceleration-time measurements on four shots show vertical peaks ranging from 1000 to 2000 g. Mass-flow in jet emerging from a 36-inch-diameter open hole was greater than estimated on the basis of a steady-flow model, suggesting that the cross-section of the jet flow field is non-uniform at early times. Similar measurements for the 4-inch-diameter hole, as well as airblast measurements and photography, suggest that this hole "pinched off" at an early time. (auth)

9536 (SC-RR-720634) METHODS OF PROCESSING, EVALUATING, AND RECOVERING AIRBLAST DATA. Vortman, L. J.; Long, J. W. (Sandia Labs., Albuquerque, N. Mex.). Dec 1972. 66p. Dep. NTIS.

Recordings of airblast data contain baseline shifts and drifts, electrical and wind noise, and other irregularities that degrade the records. Methods of processing records to remove departures from measured portrayals to restore an accurate record are presented. A computer program developed for automatic processing of records is described and listed. Some of the procedures are applicable to records of other than airblast data. (auth)

9537 (UCRL-74018) NUCLEAR CHEMICAL MINING OF PRIMARY COPPER SULFIDES. Lewis, A. E.; Braun, R. L.; Higgins, G. H. (California Univ., Livermore. Lawrence Livermore Lab.). 11 Oct 1972. 26p. (CONF-721108-5). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

A contained nuclear explosion to produce a chimney of broken ore well below the water table is proposed. After the chimney is filled with water and reaches hydrostatic equilibrium, oxygen is introduced near the bottom of the mass of broken rock. The increase in solubility of oxygen at high hydrostatic pressure is sufficient to initiate the oxidation of the primary sulfides: chalcopyrite and pyrite. The oxidation and dissolution of these sulfides produce enough heat to increase the temperature of the ore and water in the chimney as much as 100°C. The rate of dissolution of chalcopyrite is so rapid under these conditions that the rate of copper extraction becomes limited principally by the physical accessibility of the chalcopyrite within the ore fragments. Data are presented from laboratory and pilot plant studies conducted during the past 2 yr on the rate of extraction of copper from primary sulfide ore. Results from these studies were used in developing a computer model for estimating the rate of recovery and the ultimate economic recovery of copper values in large-scale solution mining. Economic analysis showed that nuclear solution mining is very competitive with other mining techniques. The method is broadly applicable to the low-grade, deep deposits needed for future production. Problems of ground shock and radioactivity are manageable, and many environmental problems associated with conventional mining are eliminated. (auth)

9538 (UCRL-74261) GAS QUALITY AND GEOCHEMICAL STUDIES IN GAS-STIMULATION EXPERIMENTS. Taylor, R. W. (California Univ., Livermore. Lawrence Livermore Lab.). Jul 1972. 29p. (CONF-721108-6). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

Gas produced following the Gasbuggy and Rulison gas-stimulation nuclear explosions had a different composition than the natural gas produced in the same areas before nuclear stimulation. The principal difference was the presence of substantial amounts of CO_2, CO, H_2, and H_2O in the post-explosion gas. There also were changes in ratios of hydrocarbons. Because CO_2 reduces the heating value of the gas, and steam presents a troublesome disposal problem due to the trace of tritium it carries, it is necessary to understand the geochemical effects produced by these types of nuclear explosions. Samples of gas-bearing shales were heated under a variety of conditions, and it was found that CO_2 is evolved at temperatures as low as 500°C, even under a CO_2 pressure of 50 atm, due to reactions between fine-grained carbonates and silicates. In other experimental studies evidence was obtained that regions of high temperature (~400°C), rather than radiation, caused the changes in gas composition observed in the Gasbuggy chimney during the 6-month "shut-in" period. In looking ahead to the geochemical effects that occur when multiple explosions are used to form interconnecting chimneys, it was concluded that less CO_2 will be produced per unit yield than for a single explosion in the same rock. This is because the intensely heated rock is cooled rapidly by convecting gas before it can heat the adjacent rubble, which results in less rubble being heated hot enough to release CO_2. Steam production, however, will be greater in the case of multiple explosions than for single explosions because a higher fraction of the total yield is deposited as heat in the chimney, thus increasing the average chimney temperature. The average chimney temperature, and thus the steam pressure, increases as the distance between multiple explosions is decreased. The steam pressure will also increase as the depth of nuclear explosions is increased. (auth)

9539 OBSERVATIONS OF PSEUDO AFTERSHOCKS FROM UNDERGROUND NUCLEAR EXPLOSIONS. Bolt, B. A.; Qamar, Anthony (Univ. of California, Berkeley). Phys. Earth Planet. Interiors; 5: No. 5, 400-2(Oct 1972).

Recent large underground nuclear detonations in Novaya Zemlya have provided crucial new evidence of the fine structure of the Earth's upper mantle and outer core. Observations of the precursors to P'P' waves at Jamestown and Priest from explosions in 1966, 1970 and 1971 entail a sharp reflecting interface at 650 km depth. A spike doublet occurs, in agreement with predicted travel-times for a tripartite core. Additional precursor waves also were detected at least 9 s before the first spike. These waves may be reflections from minor discontinuities in a 40 km thick transition shell below 650 km. The difference between the observed wave PmKP (m = 4 and 7), reflected m − 1 times within the core exceeds by 1.4 s the difference predicted by the 1968 PcP and PKP tables at $\Delta = 69°$. (auth)

9540 EFFECT OF OVERBURDEN PRESSURE AND WATER SATURATION ON GAS PERMEABILITY OF TIGHT SANDSTONE CORES. Thomas, R. D.; Ward, D. C. J. Petrol. Technol.; 120-4(Feb 1972).

Cores used in this research were obtained from Project Gasbuggy and Project Wagon Wheel sites. Results of the investigation showed that the gas permeability of tight sandstone cores is markedly decreased with increasing overburden pressure. Most of the decrease takes place at pressures to 3,000 psi. At 3,000 psi, the permeability of unfractured samples ranges from 14 to 37% of the initial permeability. In fractured samples, permeability may be reduced to as low as 6% of initial permeability. Water saturation also reduces the gas permeability greatly; however, the relative permeability does not change significantly with overburden pressure. Permeability calculated from laboratory results are in good agreement with in-situ permeabilities determined from production test data. Although not confirmed, predictions for other projects appear to be reasonable. (T.F.D.)

Protective Structures and Equipment

9541 PERFORMANCE OF VARIOUS IMPREGNATED ACTIVATED CHARCOAL CARTRIDGES AND FILTER PAPER FOR SAMPLING AIRBORNE RADIOIODINE. Naritomi, Mitsuo; Fukuda, Seiji. Nippon Genshiryoku Gakkaishi; 14: No. 10, 531-9 (Oct 1972). (In Japanese).

In order to improve the performance of a commercially available charcoal filter paper (Toyo Roshi, Type CP-20) and of a charcoal cartridge (Toyo Roshi, Type CHC-50) for collecting airborne radioiodine under high relative humidity, the charcoals were impregnated with triethylenediamine (TEDA), stannous

iodide (SnI_2), potassium iodide ($KI + I_2$) or else with potassium thiocyanate (KSCN). The impregnated charcoals were examined for their dependence of collection efficiency on the properties of airborne iodine, on the sampling period and on the face velocity, and the results were compared with unimpregnated charcoal as reference. The airborne radioiodine used as samples was obtained from the exhaust ventilation systems at the ^{131}I production plant, and from the fuel reprocessing test plant, both belonging to the Japan Atomic Energy Research Institute. The charcoals impregnated with TEDA or SnI_2 were found to show greatly improved performance compared with the unimpregnated charcoals; the collection efficiency of the charcoal cartridge and of the charcoal filter paper was maintained at levels above 85 and 80%, respectively, over a period of 14 h of sampling. It was found, however, that the collection performance was impaired by the presence of chemically reactive gases such as NO_2 and organic vapor. The charcoals impregnated with ($KI + I_2$) and with KSCN showed almost no improvement in their collection efficiencies. (auth)

9542 REMOVAL EFFICIENCY OF ACTIVATED CHARCOAL FILTER IN THE VENTILATION SYSTEM OF A LARGE-SCALE ^{131}I PRODUCTION FACILITY. Izumo, Mishiroku; Iguchi, Akira; Yamaguchi, Isoo; (and others). Nippon Genshiryoku Gakkaishi; 14: No. 10, 540-6(Oct 1972). (In Japanese).

An air-cleaning system embodying activated charcoal filters was constructed for a large-scale ^{131}I production facility at the Japan Atomic Energy Research Institute, for the purpose of removing ^{131}I released continuously into the exhaust air stream from the production facility. The system was continuously operated for about 47 months, and changes in the removal efficiency of the ^{131}I filter for the exhaust air stream were observed during this period. In one run of ^{131}I production, the removal efficiency changed significantly, possibly due to a change in the chemical form of ^{131}I released, accompanying the progress of the ^{131}I production process. When operated at the maximum air flow rate of the filter, it showed an efficiency greater than 90% on the average over a period of 20 months. (auth)

Safety Engineering

Refer also to abstract 10010.

9543 (SC-DR-720593) CONSIDERATIONS WHEN DESIGNING, ASSEMBLING, AND OPERATING A GASEOUS HYDROGEN PRESSURE SYSTEM. Northrup, C. J. M. Jr.; Wemple, R. P.; Baudoin, L. P. (Sandia Labs., Albuquerque, N. Mex.). Nov 1972. 34p. Dep. NTIS.

Much of the information required to design, assemble, and operate a gaseous hydrogen system safely is scattered throughout the literature in a number of diverse reports and articles. This report draws on many of these technical papers and the authors' experiences to present some of the more common problems and solutions encountered when dealing with gaseous hydrogen. (auth)

9544 (WASH-1226-10) MECHANICAL (CADWELD) SPLICES IN REINFORCING BARS OF CONCRETE CONTAINMENTS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which is used to implement testing and sampling of mechanical splices in reinforcing bars used in concrete containment structures. (J.R.D.)

9545 (WASH-1226-15) TESTING OF REINFORCING BARS FOR CONCRETE STRUCTURES. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which is used to implement testing and inspection of reinforcing bars for concrete structures. (J.R.D.)

9546 DEVELOPMENT SUMMARY OF AN IMPLANTABLE VAPOR CYCLE CIRCULATORY ASSIST SYSTEM. Huffman, F. N. (Thermo Electron Corp., Waltham, MA); Bornhorst, W. J.; Harmison, L. T. pp 3.6-14 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The development of an implantable Rankine-cycle power system which actuates a left ventricular bypass pump has entered the phase of in vivo testing. Initial prototypes employ transcutaneous electrical power transmission. However, the system has been designed within the constraints of utilizing a radioisotope heat source. A LiF/LiCl eutectic mixture is used for thermal energy storage. The Rankine-cycle energy converter drives a hydraulic pump which operates a completely hydraulic control system; this system automatically counterpulses a left ventricle-to-aorta assist device with the left ventricle. Electromagnetic power transfer utilizing a tuned ferrite core primary coil and an implanted secondary coil was accomplished across intact skin at 70 to 80% efficiency and up to 150 watts of power. Ram engine and rotary Rankine-cycle energy systems have been developed. Performance has been evaluated in over 1500 hours of bench testing at power outputs of 4 to 20 watts. Components of a modified ram engine design are undergoing tests and prototypes are being fabricated. This ram engine system incorporates regeneration for higher overall efficiencies. The hydraulic control system has been tested in circulatory analogs and in vivo and has reduced left ventricular pressure by 50 to 80% at physiologic stroke volumes and heart rates. All subsystems have been integrated into a complete circulatory support system and subjected to in vivo test. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 9653.

9547 (AEC-tr-7393) PAPERS ON THE EXISTENCE OF ISOTOPIC ANOMALIES ENCOUNTERED IN URANIUM FROM GABON. Translation of Excerpts from a Press Conference held by the French Atomic Energy Commission on September 25, 1972. 36p. Dep. NTIS.

Data and information on mineral resources in Gabon are presented in which geographic, geologic, and mining activities are summarized. Information is included on significant isotopic anomalies in U ore extracted from the Oklo mine in Gabon. An explanation of these anomalies based on earlier spontaneous chain reactions which occurred in the deposits is offered. (J.R.D.)

9548 SOME PECULIARITIES IN THE DISTRIBUTION OF RADIOACTIVE ELEMENTS IN THE PLATFORM BASITES AND ULTRABASITES. Gon'shakova, V. I.; Viktorov, V. V.; Tseitlin, S. G.; Zhirova, N. K. Izv. Akad. Nauk SSSR, Ser. Geol.; No. 12, 3-13(Dec 1971). (In Russian).

Distribution of the radioactive elements U, Ra, Th, and K in platform basites and ultrabasites was studied. Alkaline and subalkaline differentiated basaltoids play a leading role in the accumulation of these elements. Alkaline basaltoids with elevated Mg and alkali content and low silica were rich in radioactive elements, so that in the aggregate with geologo-tectonic and petrologic data, their origin from basic (alkali-ultrabasic-alkali-basalt) magma is confirmed. Uranium, Ra, Th, and K contents in the chief complexes of basite and ultrabasites are discussed as occurring in the south of the Eastern–European platform. Such isotopic contents were determined in rocks and minerals by radiochemical methods. The behavior, composition, and concentration of radioisotopes represent an indicator of the petrogenetic processes. The chief factors in the distribution and accumulation of radioisotopes in rocks are the processes of magmatic and crystallization differentation and the conditions under which they occur. The article contains tabulated data on the distribution of radioactive elements in accordance with the sequence of formation of the complexes of basites and ultrabasites–older and younger. (tr-auth)

9549 THORIUM IN THE WORLD. Com. Naz. Energ. Nucl., Notiz.; 18: No. 8-9, 84-9(1972). (In Italian).

A review of the present situation of thorium in the world and in the main producing countries is presented. (auth)

9550 HEAT FLOW AND SURFACE RADIOACTIVITY AT TWO SITES IN SOUTH GREENLAND. Sass, J. H. (Geology Survey, Menlo Park, Calif.); Nielsen, B. L.; Wollenberg, H. A.; Munroe, R. J. J. Geophys. Res.; 77: No. 32, 6435-44(10 Nov 1972).

Heat flow and surface radioactivity were determined at two sites in the Precambrian shield of south Greenland. At Ivigtut heat flow q from two holes in Ketilidian (~1700–1500 My) gneisses averaged 1.0 ± 0.1 HFU (μcal cm^{-2} sec^{-1}), and the radiogenic heat production A_0 averaged 5.5 ± 1.5 HGU (10^{-13} cal cm^{-3} sec^{-1}). These data are consistent with other pairs of q and A_0 values from the Canadian and Australian shields. In four holes near the northwestern edge of the Ilimaussaq alkali intrusion of Gardar (~1000 My) age, however, q averages only 0.9 ± 0.1 HFU, whereas A_0 averages >20 HGU. This observation implies that, unless heat flow from the mantle is unexpectedly low in this part of Greenland, the highly radioactive part of the intrusion is quite thin (~1 km) and the underlying crustal rocks contain very little radioactivity. (auth)

Radioactive Effluents

Refer also to abstracts 9347, 9499, 11146, 11391, 11450, 11458, 11463, 11465, and 11469.

9551 ELECTRIC POWER AND THE ENVIRONMENT. Angelini, A. M. Com. Naz. Energ. Nucl., Notiz.; 18: No. 8-9, 33-63(1972). (In Italian).

The main problems connected with the construction of new power plants, particularly nuclear, in Italy and the measures taken to deal with them are discussed. (auth)

Radioactivity Monitoring and Transport

Refer also to abstract 9768.

9552 (BRH/ORO-72-2) 3rd ANNUAL NATIONAL CONFERENCE ON RADIATION CONTROL, NEW HORIZONS, MAY 2-6, 1971, SCOTTSDALE, ARIZONA. (Bureau of Radiological Health, Rockville, Md.). Dec 1971. 390p. (CONF-710562).

The proceedings of the Third Annual National Conference on Radiation Control, May 2 to 6, 1971, in Scottsdale, Arizona are presented. Cosponsors were the Conference of Radiation Control Program Directors, the Bureau of Radiological Health of the Department of Health, Education, and Welfare, and the Radiation Office, Environmental Protection Agency. Participants, representing all state and major local radiation control programs, as well as Federal agencies, concentrated on healing arts x-ray exposure to the public and environmental radiation protection issues. In addition to formal presentations and educational seminars, the proceedings contain reports of workshops dealing with specific x-ray and environmental radiation exposure problems. Resolutions by the Conference of Radiation Control Program Directors are also included. (auth)

9553 (EGG-1183-1554) RADIOLOGICAL SURVEY OF THE LAKE ONTARIO ORDNANCE WORKS AND VICINITY IN JUNE 1972. Technical Report No. L-1076. (Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.). 3 Nov 1972. Contract AT(29-1)-1183. 22p. Dep. NTIS.

The Aerial Radiological Measuring System (ARMS) was used to perform an aerial radiological survey of the Lake Ontario Ordnance Works and surrounding area on June 17, 1972. The data included a survey of the terrestrial background gamma radiation and an analysis of selected soil samples. A high-sensitivity detection system collected gamma-ray spectral and gross-count data. The data were then computer processed into an isoexposure contour map, 3 feet above the ground, of a 21-square-mile area. Results indicated the presence of two storage areas with a high concentration of ^{226}Ra and its daughters. In addition, an independent ground survey was conducted by the United States Atomic Energy Commission, Oak Ridge Operations Office (USAEC/ORO), during June 1972, following cleanup operations. These results are compared with the ARMS measurements. Results from both surveys confirm that, with the exception of Six Mile Creek and areas adjacent to the storage sites, the measured levels in the uncontrolled areas surrounding the site did not exceed 50 μR/hr. (auth)

9554 (LA-5097) LOS ALAMOS LAND AREAS ENVIRONMENTAL RADIATION SURVEY 1972. Johnson, L. J. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 27p. Dep. NTIS.

The details of an environmental radiological evaluation on about 5,500 acres in eight parcels of land owned by the United States Atomic Energy Commission (USAEC) in Los Alamos County, New Mexico, are presented. The environmental assessment of these real properties included a careful search of the administrative records of the Los Alamos Scientific Laboratory (LASL) to determine the extent the land might have been used or involved in the Laboratory's activities, extensive measurements of the radiation levels in the field, and radiochemical analysis of numerous soil and vegetation samples. A new portable radiation measurement instrument, designated as the Los Alamos Field Pulse Height Analyzer, was developed and used for this study. This analyzer proved to be valuable in documenting the low levels of radioactivity encountered. The results of the study showed that all measured values were comparable to reported worldwide levels, and that no radiation or radioactive contamination observations were encountered that are of radiological health or environmental concern. The results therefore support the conclusion that no abnormal environmental hazard as a result of past Laboratory activities, exists on the surveyed parcels of land. (auth)

9555 (NERC-LV-539-14) OFF-SITE RADIOLOGICAL SAFETY PROGRAM FOR PROJECT RULISON: RE-ENTRY PORTION OF PHASE III. Payne, D. W.; Grossman, R. F. (National Environmental Research Center, Las Vegas, Nev. (USA)). Nov 1972. Contract AT(26-1)-539. 263p. Dep. NTIS.

The operational procedures and results of the off-site radiological surveillance activities conducted by the National Environmental Research Center-Las Vegas (NERC-LV) from April 1970 to October 3, 1970, during the re-entry phase of the Project Rulison Production Testing Program are presented. No release of radioactivity occurred during re-entry operations, however, gas flaring operations during August released natural gas containing some radioactivity to the atmosphere. The only activity detected in the off-site area was tritium in atmospheric moisture

samples collected at two remote, unpopulated locations near the test well during a flaring operation. All other environmental samples indicated no change in off-site radioactivity levels as a result of the re-entry program. (auth)

9556 (RISO-265) ENVIRONMENTAL RADIOACTIVITY IN DENMARK IN 1971. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jun 1972. 103p. Dep. NTIS (U. S. Sales Only).

Measurements were made of fall-out radioactivity in Denmark in 1971. ^{90}Sr was determined in samples from all over the country of precipitation, soil, ground water, surface water, seawater, grass, dried milk, fresh milk, grain, bread, potatoes, vegetables, fruit, total diet, drinking water, and human bone. Furthermore ^{90}Sr was determined in local samples of air, rain water, grass, sea plants, fish, and meat. ^{137}Cs was determined in soil, milk, grain products, potatoes, vegetables, fruit, total diet, and meat, and ^{137}Cs was measured by whole-body counting in persons from a control group at Risø. Estimates of the mean contents of radiostrontium and radiocaesium in the human diet in Denmark in 1971 are given. The shorter-lived fission products (^{144}Ce, ^{141}Ce, ^{103}Ru, ^{106}Ru, ^{95}Zr, and ^{140}Ba) were determined by Ge-γ-spectroscopy in air filters. The γ-background was measured regularly at locations around Risø, at ten of the State experimental farms, and in an area in Zealand, one in Jutland where future nuclear power plants might be located and along the shores of the Great Belt. Also regular surveys of environmental samples from the Risø area are reported. (auth)

9557 (RISO-266) ENVIRONMENTAL RADIOACTIVITY IN THE FAROES IN 1971. Aarkrog, A.; Lippert, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jul 1972. 20p. Dep. NTIS (U. S. Sales Only).

Measurements of fallout radioactivity in the Faroes in 1971 are presented. Strontium-90 (and ^{137}Cs in most instances) was determined in regularly collected samples of precipitation, grass, milk, lamb, fish, seawater, bread, and drinking water. In addition, analyses of spot samples of potatoes, sea plants, vegetables, eggs, and human bone were also carried out. Estimates of the mean contents of ^{90}Sr and ^{137}Cs in human diet in the Faroes in 1971 are given. (auth)

9558 (WASH-1237) ENVIRONMENTAL SURVEY OF THE NUCLEAR FUEL CYCLE. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 339p. Dep. NTIS.

This survey assesses the environmental considerations related to the currently predominant nuclear fuel cycle for uranium dioxide (UO_2) fueled, light-water moderated and cooled nuclear power plants. The environmental impact of the UO_2 fuel cycle including mining, milling, production of UF_6, isotopic enrichment, fabrication, reprocessing, radioactive waste management, and transportation activities associated with moving materials to and from the above operations is considered. (T.F.D.)

9559 ENVIRONMENTAL ENGINEERING AND SANITATION. Second Edition. Salvato, Joseph A. Jr. Environmental Science and Technology, A Wiley-Interscience Series of Texts and Monographs. New York; John Wiley and Sons, Inc. (1972). 936p.

Twelve chapters are included; a separate abstract was prepared for one. The remaining 11 chapters contain information on: control of communicable and certain noninfectious diseases; environmental engineering planning; water supply; wastewater treatment and disposal; solid waste management; air pollution control; food protection; recreation areas and temporary residences; vector and weed control and pesticide use; housing and the residential environment; and administration. Tables of miscellaneous data, metric equivalents of commonly used English units of measurement, basic planning model, and CPM diagram are appended. (P.C.H.)

For an abstract of an individual chapter see: 9560.

9560 RADIATION USES AND PROTECTION. pp 491-541 of Environmental Engineering and Sanitation. /Salvato, Joseph A. Jr. New York; John Wiley and Sons, Inc. (1972).

Discussion is presented on: radiation fundamentals, such as definitions, the atom, isotopes, types of radiation, half-life, sources of exposure; biological effects of radiation; types of x-ray units and common hazards, such as dental x-ray machines, fluoroscopy, radiography, therapy units up to 10 MeV, improper use of x-ray equipment, x-ray and other radiation sources used in industrial and commercial establishments, and other general preventive measures; radium and other radioactive sources; radiation protection involving distance, time of exposure, contamination prevention, shielding, radiation protection guides for water, food, and air; waste disposal; environmental radiation surveillance and monitoring; radiation protection program; and other radiation sources, such as microwaves. (9 references) (P.C.H.)

Atmosphere

9561 (CEA-CONF-2066) USE OF INDIUM AS A TRACER IN ATMOSPHERIC DIFFUSION. Geisse, M.; Rzeckieki, M.; Brun, M. (Commissariat a l'Energie Atomique, Pierrelatte (France)). 1972. 11p. (In French). (CONF-720567-1). Dep. NTIS (U. S. Sales Only).

From 7th national congress on the monitoring of ionizing radiations conference; Marseilles, France (16 May 1972).

Indium was used as an activated tracer for atmospheric diffusion studies. The preparation of the tracer solution in a metallic form is discussed. The technique used to release the indium (atomization or volatilization) into the atmosphere is discussed. The techniques used to atomize the indium aerosols are described together with the packing methods used. An n, γ activation reaction was used. The γ energy spectrum of the sample after calibration is presented. The results are processed by computer. The accuracy is given together with the sensitivity of the method. The overall errors are estimated. The major disadvantages of this method are the high costs involved in analyzing samples and the expenses involved in using indium as the tracer instead of uranine. (France)

9562 (PEL-223) MONITORING OF GASEOUS RADIOACTIVE WASTE AT PELINDABA. Kruger, J.; Keet, G. M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jun 1972. 17p. Dep. NTIS (U. S. Sales Only).

Monitoring methods and monitoring instruments used for the measuring of gaseous effluents are surveyed. The need is indicated for having two systems available; one for warning indication and one for quantitative measurement of the radioactivity released. A compound filter pack used for the latter measurement is described and some characteristics of the pack are given. Some results found during operational use of the packs are given. The exhaust ventilation release points at Pelindaba are described, and the monitoring facilities at each are given. (auth)

9563 KINETICS OF UNIPOLAR CHARGING OF BETA-ACTIVE AEROSOL PARTICLES. Kirichenko, V. N.; Berezhnoi, V. M.; Shan'gin, B. V. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 1, 78-81(1 Jul 1972). (In Russian).

The kinetics of the acquisition of a positive charge by a beta-emitting aerosol particle in the atmosphere was studied. It was theoretically shown that this process of charging an aerosol particle of the order of several microns in size was determined by two dimensionless parameters: $\eta = It/Z$ (∞), depending on the electron emission rate, and $\theta = U^2t/(4D)$, depending on the particle size and sedimentation rate. With low activities and large diameters the first parameter predominates, and the process becomes quasi-steady-state, and the charge increases continuously until a steady-state condition exists. (K.S.W.)

9564 ENVIRONMENTAL RADIATION BACKGROUND VARIATIONS BETWEEN RESIDENCES. Lindeken, C. L.; Jones, D. E.; McMillen, R. E. (Univ. of California, Livermore). Health Phys.; 24: No. 1, 81-6(Jan 1973).

Environmental background radiation exposure measurements made in approximately 100 residences in the vicinity of Livermore, California, show variations in annual exposure from 52 to 130 mR. Measurements were made with CaF_2:Dy (TLD-200) dosimeters at quarterly intervals for a period of 1 y. Dwellings were typically wood-frame structures with stucco exteriors. Interior exposure rates were, on the average, about 25% lower than those out of doors. Dosimeters were used without energy filters, since it appears photons with energies less than 100 keV contribute little to the total dose from natural radiation sources. Elimination of energy filters materially simplifies packaging and handling requirements for these measurements. (auth)

9565 DETERMINATION OF ATMOSPHERIC EXCHANGE RATES FROM CONCENTRATION MEASUREMENTS OF FISSION PRODUCTS. Hartwig, S.; Sittkus, A. (Max-Planck Institut fuer Kernphysik, Heidelberg). Z. Naturforsch.; 27a: No. 10, 1413-17 (Oct 1972). (In German).

By measuring the isotopes ^{32}P, ^{33}P, and ^{7}Be in rain samples for several years in Freiburg, it was possible to determine two tropospheric eddy diffusion coefficients. The results of the calculations for the summer period are: K_z (vertical coefficient) = 3×10^5 cm^2/s, $K_{\varphi\varphi}$ (horizontal coefficient) = 4×10^9 cm^2/s, and for the winter period: $K_z = 1.5 \times 10^5$ cm^2/s, $K_{\varphi\varphi} = 2 \times 10^{10}$ cm^2/s. $K_{\varphi\varphi}$ is valid as well for the stratosphere. (auth)

9566 SOME ASPECTS OF THE ATMOSPHERIC BEHAVIOR OF RADIOSTRONTIUM AND OTHER FISSION PRODUCTS. Noyce, J. R. Fayetteville, AR; Univ. of Arkansas (1972). 145p. University Microfilms Order No. 72-29,719.

Thesis.

Three projects were undertaken to study some of the atmospheric behavior of fission products, in particular the important radionuclides ^{89}Sr and ^{90}Sr. Indirectly then, it is the atmosphere that was the subject of these investigations, by using radioactivities as tracers of atmospheric processes. The areas investigated were temporal distributions of radioactivity and $^{89}Sr/^{90}Sr$ ratios during two rains, precipitation scavenging of radiostrontium after the ninth Chinese atmospheric nuclear test, and interhemispheric transport of fallout from the 1970 French nuclear detonations to the Southern United States. In the first study, radionuclide concentrations for ^{89}Sr, ^{90}Sr, ^{144}Ce, and ^{137}Cs were sequentially sampled from two different rainstorms to study the behavior as a function of rainfall rate. This was during the summer of 1969, approximately seven months after the eighth Chinese atmospheric nuclear explosion of December 27, 1968. Great time variability in the $^{89}Sr/^{90}Sr$ ratio was found in conjunction with a well-developed convective-type storm on July 21, but a nearly steady ratio was observed in a stratified, stable-type storm on August 14. For both storms, a strong trend was found to exist for concentrations of radioisotopes to decrease with increase in rainfall rate. Several meteorological factors, including the dilution effect, influenced the patterns seen in the experimental data. In the second study, ^{89}Sr and ^{90}Sr were measured in rain water and air at Fayetteville, Arkansas, for nine months after the ninth Chinese atmospheric nuclear test. $^{89}Sr/^{90}Sr$ activity ratios showed behavior very similar to what was observed after the eighth Chinese atmospheric test. Ratios of ^{89}Sr activity in rains to activity in air samples were computed, and likewise for ^{90}Sr. These precipitation scavenging (PS) ratios were found to vary widely, but those for ^{89}Sr tended to be higher than those for ^{90}Sr. They did not have any well-defined relation with time, amount or rate of rainfall, or a number of other meteorological parameters. The data indicated a consistent relationship between fallout and rainfall may be necessary for PS ratios to be meaningful and useful on a short-term basis. During the last of these studies low-level radioactivity from the summer 1970 French nuclear test series in the South Pacific Ocean was detected on several occasions at Key West, Florida (25°N, 82°W), and Fayetteville, Arkansas (36°N, 94°W). Isotopic ratios indicated the interhemispheric transit time to the Southern United States during that period was on the order of five to seven weeks. Debris reached Key West before Fayetteville; the arrival dates usually differed by less than one week. These facts, along with a comparison of transit times to several locations in the Northern Hemisphere after the 1968 French tests, suggested that debris reached the United States via Hadley cell circulation. (Diss. Abstr. Int., B)

9567 NATURAL α-ACTIVITY OF THE AIR NEAR THE GROUND. PART A. METHOD OF MEASURING AND A FEW PRELIMINARY RESULTS. Israelsson, S.; Knudsen, E.; Ungethuem, E.; Dahlgren, L. (Uppsala Univ.). Tellus; 24: No. 4, 368-79(1972).

A method has been developed by which the concentration of the natural α-activity of the air near the ground can be studied over a wide range of variation. The method is based on an aspiration process. The apparatus is mainly used in order to measure rapid fluctuations of the α-activity of the air near the ground. The preliminary results presented show a connection between the fluctuations of the natural α-activity and the temperature probably due to a connecting link-the vertical motion. Further simultaneous measurements of the natural α-activity and the temperature in the layer up to 3 meters above the ground have been made. The gradients were fairly steep near the ground and decreased rapidly with height. (auth)

Soil

9568 (BNWL-1691) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, SEPTEMBER 1972. Division of Production and Hanford Plant Assistance Programs. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1972. Contract AT(45-1)-1830. 21p. Dep. NTIS.

Research progress in the environmental and regulatory technology program is reported on development of radionuclide transport models and on development of methods for predicting activity coefficients in high ion strength mixed salt solutions. Efforts in waste management programs were devoted to salt cake reduction studies. Process technology research is reported on Pu reclamation facility instrumentation, waste management instrumentation, treatment of Purex Plant stored waste sludge, CsCl melting equipment, seismology, and effluent behavior. In programs for technical assistance to the Hanford Plant, efforts were devoted to environmental evaluations, radiation protection, and radiation standards. (J.R.D.)

9569 (IDO-10049) RADIONUCLIDE DISTRIBUTION IN SOIL MANTLE OF THE LITHOSPHERE AS A CONSEQUENCE OF WASTE DISPOSAL AT THE NATIONAL REACTOR TESTING STATION. Schmalz, B. L. (comp.) (Idaho Operations Office (AEC), Idaho Falls). Oct 1972. 80p. Dep. NTIS.

A study of the distribution of radionuclides in the soil resulting from disposal of liquid and solid waste at the National Reactor Testing Station (NRTS) is reported. The situation involving liquid waste was appraised by mathematical models using parameter determined in the laboratory; physical models using soil samples and simulated waste solution; and sampling of soil and water where waste is being discharged. In the case of ^{90}Sr, the data obtained indicate that the sorption capacity of the alluvial deposits between the disposal pond bottoms and the basalt bedrock has been reached. The data for cesium were erratic but the most pessimistic interpretation indicates that the capacity of the alluvium has not been reached. The amount of ^{60}Co estimated to be in the alluvium is greater than that reported to have been discharged. The discharge estimates do not take into account the more frequent usage of unsheathed cobalt wires for neutron flux measurements during the early history of the reactors. ^{60}Co retention in the soil is attributed to reactions other than ion-exchange. A theoretical appraisal of the migration of radionuclides at the burial ground indicates that the potential hazard is small under well-drained circumstances. Leaching of waste and the migration of some fission products as well as plutonium isotopes and daughter products is shown to have occurred to a very limited extent. This is inferred to have resulted from inundation of waste as a result of poor drainage of snow-melt runoff. The concentrations and distances are small and are not interpreted as a cause for concern in regard to insulting the regional aquifer system. A hypothetical evaluation is included of the environmental problems remaining after active operation of a disposal site has been discontinued. It is concluded that disposal sites can be used for other purposes with certain restrictions. (auth)

9570 STUDY OF ^{220}Ra EMANATION DEDUCED FROM MEASUREMENT OF VERTICAL PROFILE IN THE ATMOSPHERE. Druilhet, A.; Guedalia, D.; Fontan, J.; Laurent, J. L. (Univ. Paul Sabatier, Toulouse). J. Geophys. Res.; 77: No. 33, 6508-14 (20 Nov 1972).

Continuous measurements of the concentration of thoron in the atmosphere have been carried out over a period of 8 months by using nine sampling points distributed vertically between 0 and 15 meters above ground level. The results of these measurements have been used in a statistical study of the variations of the emanation rate of thoron from the soil in terms of various parameters (such as soil moisture, temperature gradient in the soil, wind velocity). They agree with results of a previous work performed with an apparatus of direct measurement. (auth)

Ecosystems and Food Cycles

Refer also to abstracts 9874 and 9880.

9571 (TID-3917(Suppl.1)) MARINE RADIOECOLOGY: A SELECTED BIBLIOGRAPHY OF NON-RUSSIAN LITERATURE. Edmundson, Eldon, Jr. (Environmental Protection Agency, Seattle, Wash.); Schultz, Vincent (Washington State Univ., Pullman. Dept. of Zoology); Klement, A. W. Jr. 1972. Contract AT(45-1)-2221. 77p. Dep. NTIS.

Eight-hundred and forty-five references are presented to recent publications in the world literature, excluding Russian publications, on marine radioecology. (C.H.)

Radiometric Techniques

Refer also to abstracts 9595, 9688, and 9758.

9572 (AEC-tr-7392) DETERMINATION OF THE AGE OF SEDIMENTARY FORMATIONS IN THE FRANCEVILLE (REPUBLIC OF GABON) BASIN BY THE RUBIDIUM-STRONTIUM METHOD. Bonhomme, Michel; Weber, Francis; Favre-Mercuret, Robert. Translated from Bull. Serv. Carte Geol. Alsace Lorraine; 18: No. 4, 243-51(1965). 10p. Dep. NTIS.

Seventeen determinations were made by the rubidium-strontium method on samples from the sedimentary basin of Franceville (Republic of Gabon). An age of 1740 ± 75 My has been calculated by the isochrone method for this formation. Isochrone calculation by the mean of the regression lines and error calculation are described. (auth)

9573 (UCSD-34-P-84-X-6) MARINE GEOCHEMISTRY RESEARCH. Technical Progress Report, 1971-1972. Goldberg, E. D. (Scripps Institution of Oceanography, La Jolla, Calif.). 1972. Contract AT(04-3)-34. 22p. Dep. NTIS.

Research is reported on development of geochronological tools for use in inshore environments and on analytical methods for fossil fuel combustion products. Information is included on ^{210}Pb dating of sediments, ^{228}Th- ^{232}Th geochronological studies, Th and U contents in marine barite, Ba concentration in seawater, and burning processes as measured by the soot contents of marine sediments. (J.R.D.)

9574 (UUIP-784) U/Th METHOD OF DATING MARINE CALCIUM CARBONATES AND ITS APPLICATIONS, USING IONIZATION CHAMBERS. Gustavsson, J. E.; Hoegberg, S. A. C. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 51p. Dep. NTIS (U. S. Sales Only).

A method using uranium and thorium content analysis for age determination of marine calcium carbonates is described. The upper age limit for this method is about 300,000 y. (Sweden)

9575 SUESS CALIBRATION CURVE AND ARCHAEOLOGICAL DATING. Ottaway, B.; Ottaway, J. H. (Univ. of Edinburgh). Nature (London); 239: No. 5374, 512-13(27 Oct 1972).

Reference is made to the extensive calibration curve published by Suess in 1967, based on dendrochronology, and relating radiocarbon dates to absolute time lapse. This curve is still the most widely used calibration employed by archaeologists. It contains, however, a number of re-entrant kinks, that give from two to seven possibilities when used to derive an absolute date from a "conventional" ^{14}C date in some regions of the curve. For this reason archaeologists have tended to avoid routine application of the curve because of the difficulty of quoting multiple possibilities in terms of a single probable date together with a standard deviation. A recently proposed method of treating groups of ^{14}C dates in terms of the interquartile range, however, overcomes this difficulty. Using this technique the effect of correcting two series of dates belonging to the European Neolithic for Central and Eastern Europe was studied. The most noticeable change produced by the correction is that the dates of several cultures that were previously symmetrically distributed showed a marked skew distribution, and several already skew distribution became even more asymmetrical. The asymmetrics were all associated with a sharp change in slope of the Suess curve, and if a smoothed curve had been used they would not have appeared. Detailed changes are shown for an extreme case, where samples were taken from a single stratum, only 1.75m thick, of a reliably excavated Bulgarian well. The corrected dates for each of the five levels from which the samples were taken show a range of possibilities of at least 400 y, and two of them >800 y. These effects are not due to the re-entrant kinks, but to the "staircase" profile of the Suess curve. The evidence, however, does not prove conclusively that the Suess is inapplicable to archaeological data and that a smooth curve is to be preferred. The kinks in the curves are probably related to short term fluctuations in the specific activity of atmospheric ^{14}C. (UK)

9576 ^{210}Pb, ^{210}Bi, AND ^{210}Po IN THE ATMOSPHERE: ACCURATE RATIO MEASUREMENT AND APPLICATION TO AEROSOL RESIDENCE TIME DETERMINATION. Poet, S. E.; Moore, H. E.; Martell, E. A. (National Center for Atmospheric Research, Boulder, CO). J. Geophys. Res.; 77: No. 33, 6515-27(20 Nov 1972).

Procedures developed for the sequential chemical separation and radiochemical analysis of ^{210}Pb, ^{210}Bi, ^{210}Po, and ^{90}Sr are described. Results from the measurements of these radioisotopes in surface air and precipitation are presented and discussed in relation to their sources and their application as tracers for the estimation of the residence times of particles in the lower atmosphere. It is concluded that the simple steady-state model does not apply to these long-lived radon daughters and that published residence time estimates based on $^{210}Po/^{210}Pb$ ratios are incorrect and too long. On the basis of $^{210}Bi/^{210}Pb$ activity ratios, correcting for the presence of an assumed secular equilibrium component of ^{210}Pb, ^{210}Bi, and ^{210}Po, a mean atmospheric residence time of about 4 days for particles in the lower troposphere and about 1 week for particles in precipitation is estimated. Further tests of the steady-state assumption and other factors affecting such estimates are in progress. (auth)

9577 XENON IN CARBONACEOUS CHONDRITES. Manuel, O. K.; Hennecke, E. W.; Sabu, D. D. (Univ. of Missouri, Rolla). Nature (London) Phys. Sci.; 240: No. 101, 99-101(4 Dec 1972).

It has been found that carbonaceous chondrites contain two isotopically distinct components of trapped xenon which cannot be explained by the occurrence of nuclear or fractionation processes within these meteorites. (auth)

9578 PULSED NEUTRON WELL LOGGING APPARATUS HAVING MEANS TO VARY THE NEUTRON GENERATOR PULSE REPETITION RATE. Hopkinson, E. C.; Youmans, A. H. (to Dresser Industries, Inc.). U. S. Patent 3,705,304. 5 Dec 1972. Filed 31 May 1967.

A bistable multivibrator of scale of two circuits is inserted in the sync pulse line before a pulsed neutron generator to reduce the pulse repetition rate by a factor of two. The radiation detection system within the borehole instrument is gated in the conventional manner without the repetition rate of its detection gates being reduced by the factor of two. A second bistable multivibrator circuit is inserted in the sync pulse line before the sync pulse cable driver, the second multivibrator circuit causing the surface electronics to accept signal information during the first half of an elongated cycle which has not been corrected for activation background, and to accept information during the second half of the cycle which relates only to activation background. The signal information is combined with the background information to provide data relating to the decline of the thermal neutron population which is independent of the activation background counting rate. (Official Gazette).

Site Surveys

Refer also to abstracts 9347 and 9553.

9579 (DOCKET-701319-3) TEST AND RESEARCH REACTOR FUEL ELEMENT FABRICATION PLANT. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 59p. Dep. NTIS.

The known and potential environmental effects associated with operation of the proposed Test and Research Reactor Fuel Element Fabrication Plant are discussed. The discussions are based on information contained in Docket #701319. Information is included on the site, the plant, environmental effects, costs, benefits, and plant alternatives. (J.R.D.)

9580 (TID-26234) WATER SUPPLY FOR THE NUCLEAR ROCKET DEVELOPMENT STATION AT THE U. S. ATOMIC ENERGY COMMISSION'S NEVADA TEST SITE. Geological Survey Water-Supply Paper 1938. Young, R. A. (Geological Survey, Washington, D. C.). 1972. 20p. Dep. GPO.

The Nuclear Rocket Development Station, in Jackass Flats, occupies about 123 square miles in the southwestern part of the U.S.A.E.C.'s Nevada Test Site. Jackass Flats, an intermontane valley bordered by highlands on all sides except for a drainage outlet in the southwestern corner, has an average annual rainfall of 4 inches. Jackass Flats is underlain by alluvium, colluvium, and volcanic rocks of Cenozoic age and, at greater depth, by sedimentary rocks of Paleozoic age. The alluvium and the colluvium lie above the saturated zone throughout nearly all of Jackass Flats. The Paleozoic sedimentary rocks contain limestone and dolomite units that are excellent water producers elsewhere; however, these units are too deep in Jackass Flats to be economic sources of water. The only important water-producing unit known in the vicinity of the Nuclear Rocket Development Station is a welded-tuff aquifer, the Topopah Spring Member of the Paintbrush Tuff, which receives no significant recharge. This member contains about 500 feet of highly fractured rock underlying an area 11 miles long and 3 miles wide in western Jackass Flats. Permeability of the aquifer is derived mostly from joints and fractures; however, some permeability may be derived from gas bubbles in the upper part of the unit. Transmissivity, obtained from pumping tests, ranges from 68,000 to 488,000 gallons per day per foot. Volume of the saturated part of the aquifer is about 3.5 cubic miles, and the average specific yield probably ranges from 1 to 5 percent. The volume of ground water in storage is probably within the range of 37 to 187 billion gallons. This large amount of water should be sufficient to supply the needs of the Nuclear Rocket Development Station for many years. Water at the Nuclear Rocket Development Station is used for public supply, construction, test-cell coolant, exhaust cooling, and thermal shielding during nuclear reactor and engine testing, and washdown. Present (1967) average consumption of water is 520,000 gallons per day—all supplied by one well. This supply well and a standby well have a production capability of 1.6 million gallons per day—adequate for present needs. Water in the welded-tuff aquifer is of the sodium bicarbonate type. Dissolved-solids content of the water in Jackass Flats is in the general range 230 milligrams per liter in the western part to 890 milligrams per liter in the eastern part. (auth)

9581 (TID-26235) INTERPRETATION OF AN AEROMAGNETIC SURVEY OF THE AMCHITKA ISLAND AREA, ALASKA. Geological Survey Professional Paper 707. Bath,

G. D.; Carr, W. J.; Gard, L. M. Jr.; Quinlivan, W. D. (Geological Survey, Washington, D. C.). 1972. 29p. Dep. GPO.

An aeromagnetic survey of about 1,800 square miles of Amchitka Island and the adjacent insular shelf has provided information on Tertiary volcanic, intrusive, and sedimentary rocks. This includes identification of rocks that cause anomalies and the lateral extents, structures, and approximate depths of those rocks. Near proposed drill sites, anomalies were examined for features that might be related to faulting. The survey was facilitated by data on the magnetic properties of 347 rock specimens collected from surface exposures and 216 from drill cores and by plots of 25 miles of ground magnetic traverse. The data on magnetic properties furnished bases on which anomalies were related to geologic features; ground surveys classified near-surface rocks as either lava or breccia. Computation of the effects of sheetlike models shows that the steeper gradients of theoretical anomalies are positioned near the ends of flows or sills that have been terminated by faulting. Drill sites were selected in areas away from gradients considered to be fault related. Nearly all prominent anomalies over land and many over water can be reasonably interpreted and can be correlated with known geologic features. Anomalies and geologic data suggest that the magma of the Chitka Point Formation orginated in a large volcanic center on western Amchitka Island and eastern Rat Island. Faults that are well delineated by aeromagnetic contours on Amchitka do not appear to extend very far seaward, and marked submarine trenches that have the same general trend are not well defined magnetically. (L.C.L.)

9582 (UCID-15751) PERMEABILITY OF GAS RESERVOIR SPECIMENS: PROJECT WAGON WHEEL. Quong, R.; LaGuardia, V. J. (California Univ., Livermore. Lawrence Radiation Lab.). 10 Nov 1970. 4p. Dep. NTIS.

The matrix permeability was measured in rock specimens recovered from the site of the proposed Wagon Wheel Project—an experiment in nuclear stimulation of a gas reservoir. The gas permeability of specimens recovered at depths between 8,900 to 10,500 ft was found to be highly variable, depending on the rock type, porosity, and degree of water saturation. Measurements were made over a range of confining pressures (simulated overburden) up to 12,000 psi. At this pressure, which is approximately equal to 10,000 ft of overburden, specimen permeability ranged from 1×10^{-6} millidarcys (mD) for fine-grained siltstone to $2\text{-}3 \times 10^{-3}$ mD for larger grained sandstones. (auth)

Thermal Effluents

Refer also to abstracts 9463, 11450, 11458, 11463, 11465, and 11469.

9583 (HEDL-TMF-72-101) COOLING PONDS: A SURVEY OF THE STATE OF THE ART. Sonnichsen, J. C. Jr.; Engstrom, S. L.; Kolesar, D. C.; Bailey, G. C. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1972. Contract AT(45-1)-2170. 114p. Dep. NTIS.

Since the enactment of the Water Quality Act of 1965, there has been an increasing concern over the quality of the nation's waters. Adoption of temperature standards for water bodies, combined with the economics of scale, is resulting in increased use of alternatives to once-through cooling systems, particularly ponds and towers. Approximately 60 steam-electric power plants with capacities greater than 60 electrical megawatts use cooling ponds. A review of cooling pond technology in which major emphasis was placed on examination of engineering and environmental aspects of design, mathematical and physical modeling, use of sprays, and economics is presented. (auth)

9584 UTILIZATION OF THERMAL EFFLUENT TO LENGTHEN THE ST. LAWRENCE SEAWAY SHIPPING SEASON. Kenyon, R. A. (Rochester Inst. of Tech., NY). pp 6,9-16 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

It has been often said that one man's meat is another man's poison. The thermal effluent from a nuclear power plant may be considered an ecological threat and thus deemed "thermal pollution" or it may be utilized to provide practical benefit for all concerned. It has been proposed to construct a 300,000 to 350,000 KW oreeder reactor nuclear plant on the St. Lawrence River just above the Eisenhower and Snell Locks of the St. Lawrence Seaway shipping channel. The design of a system for controlled discharge of the cooling water from this generating plant into the two lock chambers and the Wiley-Dondero Canal that will facilitate extended utilization of the seaway system without deleterious effects to the river or its ecology is proposed. (auth)

9585 FISHES OF BARNEGAT BAY, NEW JERSEY, WITH PARTICULAR REFERENCE TO SEASONAL INFLUENCES AND THE POSSIBLE EFFECTS OF THERMAL DISCHARGES. Marcellus, K. L. New Brunswick, NJ; Rutgers-The State Univ. (1972). 204p. University Microfilms Order No. 72-27,574.

Thesis.

Semimonthly and monthly fish collections were made in Barnegat Bay, New Jersey, for three years prior to and for one year following the initiation of operation of a nuclear-powered electricity generating station. Seasonal and spatial distributions and abundances of fishes before the bay received a calculated 10°C above ambient temperature discharge of 460,000 gallons per minute were to be compared with data collected after operations were initiated to evaluate the influences, if any, of the heated effluent on fish. At each of 8 stations 7 standard-size hauls were made each collection period using a 35 × 6 foot seine. The catch per haul was separated to species and the number of each was recorded. The average catch-per-unit-effort, C/E, for collection periods was calculated for relative abundance estimates. Length data were obtained from various species. Water temperature, salinity and dissolved oxygen data were also recorded. A total of 234,416 fish representing 60 species in 34 families were captured in 2786 seine hauls. Annual C/E values ranged from 53.739 to 125.690 and averaged 83.840 fish per seine haul. The largest C/E values were recorded during summer months when young-of-the-year fish were large enough to be captured. Twenty seven species had wide spatial distributions in the bay being found at 7 or more stations. All stations had quite similar species compositions as indicated by large community similarity coefficients. Station 5, near the mouth of the discharge canal showed a significant change in species composition when the generating station was operating. Eight species of fish made substantial shifts in abundance rank at station 5, apparently as a result of increased temperatures and/or water currents. The thermal addition apparently attracted fish during colder seasons but repelled them during warmer seasons as indicated by variations in catch statistics. Previously unrecorded species were found at station 5 after the generating station was operating. The influence of the thermal addition was measurable only at station 5. Atlantic silverside, a permanent resident, contributed 50.5 percent to the total catch. Annual C/E values were significantly different at the 5 percent level. The species was attracted to the heated effluent in the winter. Spawning may have been advanced or growth rate increased by the thermal addition as young fish were caught earlier than normal after the generating station was operating. Young-of-the-year fish grew nearly 0.4 mm/day during the summer. Bay anchovy, caught between April and October, ranked second in abundance. Annual C/E values were not significantly different. Adult fish were found in the heated effluent during the summer but young fish were not. Young-of-the-year fish grew approximately 0.18 mm/day during the summer. Fourspine stickleback, a permanent resident, ranked third in abundance. Annual C/E values were significantly different and indicated a decline in abundance during the study. They were not caught in the heated effluent during the summer. Tidewater silverside, a permanent resident, ranked fourth in abundance. Annual C/E values were significantly different. They were attracted by the heated effluent in the winter but not in the summer. Young-of-the-year fish grew 0.19 mm/day during the summer. Silver perch ranked fifth in abundance, were found between May and October, and were tolerant of heated effluents near 32°C, contrary to laboratory findings. Growth of young fish averaged 0.81 mm/day. Northern puffer, ranked sixth in abundance, were found from May to October and were not caught in the heated effluent during the summer. Young fish grew 0.93 mm/day (Diss. Abstr. Int., B)

9586 HEAT TRANSFER IN A COOLING POND. Averkiev, A. G.; Makarov, I. I.; Kind, K. Ya. pp 325-32 of Fourteenth Congress of the International Association for Hydraulic Research, Vol. 1. Paris; Societe Hydrotechnique de France (1971).

From fourteenth congress of the International Association for Hydraulic Research; Paris, France (29 Aug 1971). See CONF-710843-(Vol.1).

Stratified flow in rivers and reservoirs used as water supplies for thermal power plants is discussed. The nature of the heat transfer in a reservoir is dependent on the type of water source used. Experimental results obtained using simplified models for a river and a stagnant pond are presented. The densimetric number of Froude is used as the principal similitude criterion. In the case of a river, a relation was obtained by defining the variation in the length of the thermocline with the increase in the Froude densimetric number. It is suggested that the design efficiency of

a cooling pond can be evaluated from $t_1 - t_2/\Delta t = f(\Sigma\Omega_i/\Omega)$ curves obtained from laboratory or field data. The temperature of the cooled water should be determined using the method described in a previous paper submitted to the 13th IAHR congress. (France)

9587 THERMAL DIFFUSION OF THE WARM WATER OF POWER PLANTS INTO A SEA BASIN. El Mahgary, Y. S. (Imatran Voima Osakeyhtio, Helsinki). pp 333-40 of Fourteenth Congress of the International Association for Hydraulic Research. Vol. 1. Paris; Societe Hydrotechnique de France (1971).

From fourteenth congress of the International Association for Hydraulic Research; Paris, France (29 Aug 1971). See CONF-710843-(Vol.1).

The equation of thermal diffusion in a sea basin is examined assuming that the coefficient of thermal diffusion increases according to the scale. The relation between the thermal diffusion coefficient and the scale was assumed the same as that between the mass diffusion coefficient and the scale. The term representing the change in enthalpy is examined. The usual formula used for evaluating the heat of evaporation was modified in order to take into account the effect of free convection. In addition a convenient formula is introduced to estimate the net solar radiation. (France)

9588 EFFECT OF THE POWER PLANT THERMAL LOAD ON THE BAY OF NAANTALI. El Mahgary, Y. S. (Imatran Voima Osakeyhtio, Helsinki). pp 341-8 of Fourteenth Congress of the International Association for Hydraulic Research. Vol. 1. Paris; Societe Hydrotechnique de France (1971).

From fourteenth congress of the International Association for Hydraulic Research; Paris, France (29 Aug 1971). See CONF-710843-(Vol.1).

Field measurements were carried out to determine the effect of discharging the warm cooling of the Naantali Power Plant (Finland) on the physical and chemical properties of the water in the bay of Naantali. Surveys of water temperature in the bay of Naantali and measurements of the physicochemical properties of the water at the plant inlet and outlet were carried out four times during the year. Meteorological information was recorded at the same time. The results demonstrate that a sharp drop in temperature occurs within a few meters at the outlet, and that the physicochemical properties of the water in the bay are not significantly affected. (France)

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 9265, 9768, 9886, 10074, 10117, and 11290.

9589 (AD–745578) COMPUTER PROGRAM FOR ACTIVITY DETERMINATIONS IN THE USAFSAM WHOLE-BODY COUNTER. Rupp, T. D.; Nelson, R. C. (School of Aerospace Medicine, Brooks AFB, Tex.). Jun 1972. 43p. (SAM-TR–72-10). NTIS.

The USAFSAM whole-body counter requires very precise calibration if it is to determine with accuracy the amounts of specific radioisotopes contained in a human body. Rigorous detection efficiencies for the isotopes of interest must be established in all channels of the instrument and frequently monitored. Calculations for accurate calibration and sample determination involve lengthy matrix operations which are too time-consuming for repetitive manual procedures. Presented is a computer program for the accurate computation of the amount of radioactive material, as measured by the USAFSAM whole-body counter, in a human body. The approach and development of the program and mathematical techniques are discussed, and all factors involved in the program are described in detail. (auth)

9590 (JINR–P13-6748) BLOCK "CAMAC" FOR INFORMATION READOUT FROM THE PROPORTIONAL CHAMBER ELECTRONICS. Guzik, Z.; Turala, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The block "CAMAC" is described for information readout from the recording electronics of 16 proportional chambers of 512 wires. The scheme makes a fast selection of useful information and transmits it to the computer in coding form. (auth)

9591 (LBL–1321) LIQUID-XENON-FILLED WIRE CHAMBERS. Derenzo, S. E.; Flagg, R.; Louie, S. G.; Mariam, F. G.; Mast, T. S.; Schwemin, A. J.; Smits, R. G.; Zaklad, H.; Alvarez, L. W.; Muller, R. A. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 22p. (CONF-720923–9). Dep. NTIS.

From 16th international conference on high energy physics; Chicago, IL (6 Sep 1972).

Several types of small liquid xenon-filled chambers, each optimized for a particular property such as a real-time spatial resolution of $\pm 15\mu$, a time resolution of $\pm 10^{-7}$ sec, or a pulse height of 10^{-12} coulomb, are described. Larger chambers combining all these properties will be of great value at NAL energies, and describe some of the techniques necessary for their construction are described. (auth)

9592 (LUIP-CR–72-9) RELATION BETWEEN RESTRICTED ENERGY LOSS AND TRACK WIDTH IN NUCLEAR EMULSIONS. Jensen, M.; Larsson, L.; Rosander, R. (Lund Univ. (Sweden). Dept. of Physics). Jul 1972. 12p. Dep. NTIS (U. S. Sales Only).

The restricted energy loss of charged particles is a useful parameter in the description of heavy ion tracks and in the calibration of mean track width measurements in nuclear emulsions. This parameter considers only energy transfers to secondary electrons up to a fixed maximum value. The relationships between the photometrically determined mean track width and the restricted energy loss for heavy ion tracks in nuclear emulsions are presented. Within the errors of measurements there exists a one-to-one correpondence between these two quantities in the range investigated. (Sweden)

9593 (ORO–2854-14) STRUCTURAL RELAXATION IN LIQUIDS AND GLASSES. Scientific Final Report. Litovitz, T. A. (Catholic Univ. of America, Washington, D. C. Dept. of Physics). 14 May 1972. Contract AT(40-1)-2854. 9p. Dep. NTIS.

It is shown that particle track detection is feasible using a "glass chamber." However, the detection process is very sensitive to material composition of the detector, and further careful study is needed to establish the optimum conditions of composition and thermal treatment for which the rate of preferential nucleation of phase particles on track sites is maximized before the track damage is annealed out. (auth)

9594 (PTB-EW–1/72) LIGHT PORTABLE PULSE HEIGHT ANALYZER FOR USE IN RADIATION PROTECTION. Ebeling, G.; Seyfried, P. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jul 1972. 63p. (In German). Dep. NTIS (U. S. Sales Only).

The design and construction of a portable multichannel pulse-height analyzer is described in detail. MOS-slide pulse storage is used as series storage in combination with an analog-digital converter. The analog-digital converter, accumulator, pulse-beat generator, digital-analog converter, time preselection, and power supply are described. (J.S.R.)

9595 (UUIP–786) AN IONIZATION CHAMBER FOR ^{222}Rn MEASUREMENTS. Hoegberg, S. A. C.; Gustavsson, J. E. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 15p. Dep. NTIS (U. S. Sales Only).

An ionization chamber for ^{222}Rn-measurements is described. The instrument is intended for checking the radon content in materials (marine shells and corals) when using the uranium-thorium method for age-determinations. Calibration, performance and operation of the ionization chamber are discussed. (Sweden)

9596 BARREL COUNTER (11 May 1971) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE–2271).

25 drawings.

The 30-gal. barrel counter, which is described, is an instrument used primarily for the assay of Pu. Neutrons from the spontaneous fission of the ^{240}Pu contained within the sample are detected with a polyethylene moderated neutron coincidence counter containing BF_3 detectors. The observed coincidence counting rate is proportional to the ^{240}Pu content, and thus the Pu content, of the sample. This counter was designed for samples up to 30 gal. capacity, however a standard 55-gal barrel will also fit within the counter. (auth)

9597 RADIATION SENSITIVE MATERIALS CONTAINING BIPYRIDILIUM SALT OF A STRONG ACID. Andrews, T. D.; Short, G. D.; Thomas, I. (to Imperial Chemical Industries Ltd.). U. S. Patent 3,697,528. 10 Oct 1972. Priority date 24 Nov 1969, Great Britain.

Radiation sensitive materials based on nitrogeneous dications such as bipyridyls were developed using water soluble polymers as supports. Sensitizers and desensitizers are described. The materials are sensitive to x rays, electrons, and uv up to about 500 nm, in the presence of sensitizers. (auth)

9598 APPLICATIONS OF SUPERHEATED SUPERCONDUCTING COLLOIDS AS PARTICLE DETECTORS. Drukier, A. K. (Univ. of Copenhagen); Valette, C. Nucl. Instrum. Methods; 105: No. 2, 285-7(1972).

A charged particle passing through a superconducting colloid in the metastable, superheated state leads to a measurable change of the inductance of a surrounding pick-up coil; this principle can be used to build detectors of charged particles. (3 figures) (auth)

9599 PRECISE 14-MeV NEUTRON DETECTOR. Feu Alvim, C. A.; Dos Santos, A. N. (Instituto de Pesquisas Radioativas, Belo Horizonte, Brazil). Nucl. Instrum. Methods; 105: No. 2, 289-92(1972).

A 14-MeV neutron detector is proposed which is capable of excellent discrimination against lower-energy neutrons and gamma and beta rays. It is based on the detection with a ZnS scintillator of the alpha particles resulting from the $^{12}C(n,n')3\alpha$ reaction in a carbon foil. The detector agrees within 1% with the standard copper foil activation method, and shows negligible response to interfering radiations, excellent linearity, no aging effects, and prompt response. Hence, it can be utilized as the sensor for a servomechanism to control the neutron flux in 14-MeV neutron generators. (2 figures) (auth)

9600 DIFFUSION OF LITHIUM INTO GERMANIUM AT LOW TEMPERATURES. Kegel, G. H. R. (Lowell Technological Inst., MA). Nucl. Instrum. Methods; 105: No. 2, 381-2(1972).

A technique of diffusing lithium into germanium at low temperatures by using a Li–Pb alloy as an external phase is described. (auth)

9601 CRYSTALLINE QUARTZ TRACK DETECTOR FOR HEAVY CHARGED PARTICLES. Sowinski, M. (Institut de Physique Nucleaire, Orsay, France); Stephan, C.; Czyzewski, T.; Tys, J. Nucl. Instrum. Methods; 105: No. 2, 317-22(1972). (In French).

Plates made of crystalline quartz cut along the 100 plane of synthetic monocrystals were used as nuclear track detectors. Different calibrations were made with fission fragments. The influence of temperature on latent tracks and the effect on the detector of severe irradiation by neutrons were especially studied. (9 figures) (auth)

9602 INVESTIGATION OF SOME FUNDAMENTAL LIMITATIONS TO THE SPATIAL RESOLUTION OF A GAS PROPORTIONAL

COUNTER. Hough, J. (Glasgow Univ.). Nucl. Instrum. Methods; 105: No. 2, 323-8(1972).

The effect of the thermal diffusion of the charge carriers on the spatial resolution of a proportional counter is calculated and compared with experimental measurements. There is some disagreement between experiment and theory; and it seems probable that the counter avalanche spreads partially along the anode wire and plays a part in limiting the resolution under conditions of high counter gain. A method of calculating the diffusion of electrons in argon–methane mixtures from the data in the literature is outlined. (2 figures) (auth)

9603 METHOD FOR CALCULATING THE SOLID ANGLE DEFINED BY A SERIES OF DIAPHRAGMS OF ANY SHAPE. Chatelier, M.; Launois, D. (CEN, Fontenay-aux-Roses, France). Nucl. Instrum. Methods; 105: No. 2, 231-6(1972). (In French).

In experimental physics, it is often necessary to know the solid angle subtended by several diaphragms when viewed from an arbitrary point in space. A general approach to this problem is proposed, and the case of two coaxial circular apertures, is worked out more completely. (8 figures, 1 table) (auth)

9604 PULSE PILEUP REJECTOR (14 Aug 1972) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-2277).

1 drawing.

A pulse pileup rejector was designed particularly for analyzing ^{238}Pu. The rejector is based on a delay and inspect principle. The output of the linear amplifier (slow input) is DC restored and sent through a delay line (τ_d = 4.5 microseconds). The restored signal is also sent to a baseline monitor that is used to trigger the delay multivibrator and to establish the duration of the inspection period. The fast rising signal from the charge-sensitive preamplifier (fast input) is differentiated, amplified, and then discriminated. The duration signal and the discriminated fast input signal are used to set a pileup flip-flop. The termination of the duration signal is used to open the linear gate only if the pileup flip-flop is not set and if the analog-to-digital converter (ADC) in the pulse height analyzer is not busy. In this way the analyzer processes only signals that are not piled up, and the analyzer input circuits receive signals only when the analyzer is prepared to process them. (auth)

9605 COLLOQUIUM ON APPLICATIONS OF ELECTRONIC METHODS AND TECHNOLOGIES IN THE MEDICAL FIELDS, GRENOBLE, FRANCE, SEPTEMBER 15, 1971. Grenoble, France; Centre d'Etudes Nucleaires (1971). 379p. (In French and English). (CONF-710968).

This colloquium is divided into three parts: handling physiological signals; utilization of small computers; nuclear imaging. The ten papers concerning the last part were processed for NSA. (France)

For abstracts of individual papers see: 9606–9615.

9606 NUCLEAR IMAGING: INTRODUCTORY REPORT. Kellershohn, C. (Hopital Necker-Enfants-Malades, Paris). pp 255-81 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

The different types of equipment used to provide a visual display of the distribution of a radioelement in the organism are presented. The construction of this equipment, and its historical development are discussed. All such equipment involves three stages: an optical stage consisting of a hole in an opaque wall; the image converter consisting of various instrumentation; the representation of the data (subject that has undergone the most intensive research in recent times). (France)

9607 COMPUTERIZED DETECTION OF LOCAL REDUCTIONS IN RADIOACTIVE UPTAKES. STUDY BY SIMULATION AND PRELIMINARY CLINICAL EXPERIMENTS. Legras, B.; Martin, J.; Portman, M. C. (Univ., Nancy). pp 282-7 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

When the detected radioactivity is small (as is frequently the case with medical scintigraphy), random fluctuations are of considerable importance in the results obtained. An attempt was made to eliminate them by smoothing techniques. The least squares method is commonly used for this purpose. In order to objectively determine the quality of the smoothing, mathematical simulation techniques were adopted. After smoothing, the maximum quantity of information is obtained from the curve. In addition to the classical smoothing curve techniques, a method establishing irregularities in the surface smoothed was established. (France)

9608 USE OF RADIOACTIVE TRACERS IN AUTOMATING HEMODYNAMIC MEASUREMENTS. Josserand, P. (Univ., Toulouse); Farre, J.; Aragon, B.; Pontonnier, G.; Grandjean, H. pp 288-95 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

An original method of measuring the placental blood flow in pregnant women is described. ^{133}Xe is injected into the organ to be studied. The curves obtained, which represent the local radioactivity as a function of time, are designated: dilution or clearance curves. A prototype apparatus was developed, which performs, entirely automatically, the appropriate calculations on these curves. Numerical solutions are adopted, which facilitate a visual display of the information obtained, and a possible computerized treatment of the results. (France)

9609 MATHEMATICAL PROCESSING OF SCINTIGRAPH IMAGES. Ottavi, Henri (CEN de Cadarache, Saint-Paul-les-Durance, France). pp 296-301 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

The separating power and the luminosity of the scintigraphic image obtained using a collimating grid with a flat γ emitting object plane, are two incompatible parameters. The purpose of the mathematical processing adopted is to obtain a sharp image from a blurred bright image. It was found that a relatively fine grid gave the best image after processing. With such a grid, the image is almost as good before processing as after processing, the processing acting as a smoothing technique. It is shown that it is more important to have a good grid than a good processing system. (France)

9610 STATIONARY DETECTORS IN NUCLEAR MEDICINE. Lansiart, A. (CEN de Saclay, Gif-sur-Yvette, France). pp 302-12 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

Stationary detectors enable various different objects to be observed: small or large thick organs, rapidly moving objects, e.g., a radioactive embolus crossing the cardiac cavities. The detection problems encountered concern principally: the contrast of the object, the resolution of the collimator and the detector, the absorption and scattering of the radiation in the patient examined, and the detector efficiency. After having examined these various parameters, it was concluded that an improvement in the intrinsic resolution of the detector would only provide a better image for objects having sufficiently high contrast. (France)

9611 CURRENT NUCLEAR IMAGING STUDIES AT LETI. Allemand, R. (CEN, Grenoble, France). pp 313-19 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

In view of biological applications, LETI has devoted considerable attention to nuclear imaging problems (i.e., isotopic cameras for statistic or dynamic studies). A new type of stationary detector is described "multidetector." Several types of multidetector are proposed: a prototype for morphological studies of the thyroid using ^{125}I; a portable apparatus for measuring myocardial irrigations using ^{131}I; a large camera for lung explorations. Further studies are currently being undertaken at LETI on the detection efficiency. (France)

9612 GAMMA CAMERAS WITH IMAGE INTENSIFIERS. Roux, G.; Gaucher, J. C.; Lequais, J.; Lansiart, A. (CEN de Saclay, Gif-sur-Yvette, France). pp 320-34 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

Gamma cameras incorporating image intensifiers were constructed using two basic structures. In the first structure, the image of a flat, relatively thin crystal detector is formed on the photocathode of a high gain intensifier. In the second structure, the crystal detector is pushed up against the entrance window of a light amplifier tube which reduces the image size. These gamma cameras may involve either direct amplification of the scintillations or an electronic reconstitution of the scintillation coordinates. (France)

9613 CLINICAL RESULTS OBTAINED WITH A PROPORTIONAL MULTIDETECTOR: OUTLOOK FOR THE FUTURE. Floyrac, R.; Planiol, T.; Itti, R.; Garnier, G. (Centre Hospitalier Regional Bretonneau, Tours, France). pp 335-41 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

Workers in this field have shown interest in the medical applications of this new type of γ ray detector. The ease with which it can be used, the quality of the information collected, and the outlook concerning future developments are discussed. The multidetector was originally used for thyroid exploration with ^{125}I, the results obtained being comparable with those obtained using a scintigraph. An advantage of this apparatus is the fact that it enables the rate of fixation to be obtained at the same time as the image. An image that can be interpreted is obtained with exposure times between 1 and 2 minutes. (France)

9614 USE OF LIQUEFIED NOBLE GASES IN HIGH EFFICIENCY DETECTORS: APPLICATIONS TO ORGAN MAPPING. Prunier, Jacques (CEN, Grenoble, France). pp 342-7 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

Gas multidetectors are very useful in detecting the x or γ radiation emitted by tracer elements fixed in organs. Their use is, however, somewhat limited by the inefficiency of energy type detectors, the gamma radiation emitted not being fully exploited. Investigations were carried out in order to develop a more dense detector medium, thus having a higher efficiency. The use of liquid media was envisaged: liquid argon; liquid xenon. Liquid argon can be used for detecting γ radiations having energies between 200 keV and 1 MeV. (France)

9615 X RAY IMAGING WITH SPARK CHAMBERS. Morucci, J. P.; Seigneur, A.; Lansiart, A. (CEN de Saclay, Gif-sur-Yvette, France). pp 348-57 of Colloquium on Applications of Electronic Methods and Technologies in the Medical Fields. Grenoble, France; Centre d'Etudes Nucleaires (1971). (In French).

From Colloquium on applications of electronic methods and technologies in the medical fields; Grenoble, France (15 Sep 1971). See CONF-710968.

The spark chamber was the first stationary detector providing a visual display of low energy x or γ radiations. The resolution of this detector renders it, particularly, useful for thyroid exploration using ^{125}I. Only the x-ray optics limit the resolution of this equipment. In consequence, special collimators were developed, several different techniques being utilized. Various applications for studies with small animals are envisaged together with studies of the fixation of transuranic elements. (France)

9616 PROCEEDINGS OF THE AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE ANNUAL MEETING. Phys. Med. Biol.; 17: No. 1, 114-40(Jan 1972).

Abstracts are presented of 87 papers read at a 2 day meeting. The following subjects were discussed: (1) Linear accelerators and their use in radiotherapy, including automation, beam optics, dose distributions. (2) Improvement of diagnostic techniques. (3) Diagnostic x-ray exposure of patients and staff. (4) Radiation therapy, including dosimetry and the use of phantoms, with particular reference to rectal, bladder and bone-marrow and gonad dosimetry, spatial dose distributions, measurement of quality factor. (5) Nuclear medicine, including in vivo determination of Ca, whole-body counting, radioisotope techniques with particular reference to ^{131}I and ^{133}Xe. (5) Instrumentation and the use of computers in radiotherapy. (UK)

9617 SOLID STATE DETECTORS FOR NUCLEAR TRACKS WITH ON- AND OFF-SENSITIVITY. Schopper, E.; Henig, G.; Schott, J. U.; Zoergiebel, R. (Univ., Frankfurt am Main). pp 2511-15 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A new concept of trackforming solid state detectors is described. The detector alternatively either records the track of a nuclear particle—i.e. it accumulates tracks of particles for later revealing—or drops the track after the passage of the particle. The unrevealed latent tracks of particles in these detectors are unstable in time, unless they are not explicitly stabilized during the passage of the particle by irradiation with weak visible light. The detectors consist of 200 to 500 micron thick sheets of Cd-doped silver chloride-crystals on quartzglass. The tracks are revealed by irradiation with ultraviolet light. The facility of setting sensitivity thresholds by the doping conditions, and of triggering the recording of tracks on and off, enlarges the application of the visual solid detectors in combination with electronic devices. Examples are given of tracks of heavy ions and of primaries from cosmic radiation. (auth)

9618 CHARGE AND ENERGY INFORMATION FROM HEAVY ION TRACKS IN LEXAN. Stern, R. A.; Price, P. B. (Univ. of California, Berkeley). Nature (London) Phys. Sci.; 240: No. 100, 82-3(27 Nov 1972).

A new technique is described that permits heavy ions of very low energy to be identified and extends the scope of plastic particle detectors for use in nuclear chemistry, as well as making possible the study of low-energy interplanetary particles. In multilayer plastic stacks used to detect heavy high-energy cosmic rays or solar particles, the trajectory of a typical particle is marked by a series of etched cones at the top and bottom surfaces of the sheets through which it passes, and the cone lengths increase as the particle slows down and causes heavier ionization until, finally, in the sheet where the particle stops, the etch pit resembles the shape of a test tube. The new method can be used if the energy of the particle is so low that it fails to penetrate even a single sheet. The initial etching time is optimized so that etch cones of the particles of interest are visible but is not so long that they have reached the end of their range. The Lexan detectors are processed with 6.25M NaOH at 40°C. The etched sheet is then irradiated with intense uv light for one to two days so that the chemical reactivity of the remaining unetched portions of the trajectories is greatly increased. This is followed by a second etch, in which in order to achieve the maximum contrast between the initially etched portion and the final portion the etch time should be short, so that the final portion is a tube of ~0.3 μm diameter. Each track then contains a record of the charge and energy of the particle that produced it. The technique is proving very valuable for identifying solar particles with $6 \leq Z \leq 26$ and $1 \leq E \leq 10$ MeV/amu. (UK)

9619 HOW TO QUENCH LIGHT ATTENUATION IN PLASTIC SCINTILLATORS. Gabriele, S. A.; Giusti, P.; Massam, T.; Zichichi, A. (CERN, Geneva). Phys. Lett.; 42B: No. 4, 504-6 (25 Dec 1972).

A technique to overcome the problem of light attenuation in plastic scintillators has been invented. (auth)

9620 ELECTRONIC DETECTION OF TRACKS FROM IONIZING PARTICLES IN LIQUID ARGON. Dolgoshein, B. A.; Kruglov, A. A.; Lebedenko, V. N.; Miroshnichenko, V. P.; Rodionov, B. U. (Moscow Engineering-Physics Inst.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 8, 1806-9(Aug 1972). (In Russian).

A method for recording tracks of ionizing particles is described based on drawing off electrons from particle tracks in liquid argon with an external electric field, conveying the electrons to the liquid surface where electron emission occurs in the gaseous phase, and subsequent recording of the discharge in the gas. Liquid electron detectors of two types were investigated. (K.S.W.)

9621 ELECTRONICA NUCLEARA. (Nuclear Electronics). Patrutescu, M. Budapest; Editura Academiei Republicii Socialiste Romania (1972). 546p. Lei 39.

The theory, construction and design related to the application and operating principles of nuclear electronic instrumentation are elaborated. The basic properties of nuclear radiation interaction with matter are treated in close connection with the practical problems of application of detectors in nuclear experiments. The preamplifier, amplifier, and pulse-shaping circuit theory, design, and operation, are discussed. Timing and pulse height analyzing circuits (discriminators, coincidences, gates, converters) are treated starting with basic principles, and discussing the use, design, tests, and operating principles of many types of such circuits. Aspects of fast scalers and correcting circuits used in nuclear electronics are considered, and problems related to the possi-

bilities to achieve all these circuits as modular units, each of which performs an independent function, are discussed. Also, modern nuclear electronic systems with analog and digital computers, designed to monitor, control, and process data acquisition and reduction in complex nuclear experiments are described. This book having about 500 figures and 900 references is of interest for nuclear electronic engineers, technicians and students, and others who need more information on the nuclear electronic equipment applications. (auth)

9622 IZMERENIYA AKTIVNOSTI NUKLIDOV. (Measurement of Nuclide Activity). Karavaev, F. M. Moscow; Izdatel'stvo Standartov (1972). 228p.

The subject of radiometry as applied to the determination of radioactive isotopes is described. Considerable attention is given to standards, their classification, and governmental and international standards for radium mass units. Methods of absolute and relative measurement of nuclide activity are explained: fixed solid angle, 4π geometry, coincidence methods, electrostatic and ionization chamber techniques, calorimetry, and methods of absolute counting of photons and charged particles. Specific instrumentation employed in Russian laboratories is described. (187 references.) (K.S.W.)

9623 CENTRALIZED RADIATION CONTROL WITH THE USE OF COUPLING RADIOCHANNELS. Voronin, A. P.; Klimov, A. N.; Nemirovskii, B. V. Yadern. Priborostr.; No. 14, 103-10 (1971). (In Russian).

In remote control systems with dispersal parameters transducers are included directly or incidentally. Variations in the construction of the block diagram of both the channels of the transducer desk and the measurement channel of the transducer are examined. Possible variants of the incidental inclusion of the transducers are considered. It is shown that for production of the minimum output of measurements, the inclusion of transducers is advisable to be implemented in accordance with methods of quantization by functional-dependent levels. (tr-auth)

9624 PORTABLE DEVICE FOR REGISTRATION OF THE LOW SPECIFIC BETA ACTIVITY OF AQUEOUS SOLUTIONS. Bachurin, A. V.; Kuznetsov, M. M.; Morozov, V. I.; (and others). Yadern. Priborostr.; No. 14, 111-20(1971). (In Russian).

The results of the development of portable field plastic scintillation detectors for the registration of low specific β activities of aqueous solutions by the method of direct measurement are reported. The reason for the selection of the method of measurement, the electronic circuits, and the construction of the devices are presented. It was shown that the sensitivity of the device is 2.5×10^9 for $^{90}Sr + ^{90}Y$; 1.34×10^9 for ^{137}Cs; 3.23 for ^{60}Co; 3.03×10^9 for $^{144}Ce + ^{144}Pr$; 3.58×10^9 for $^{106}Ru + ^{106}Rh$; and 5.26×10^8 for ^{131}I. The possibility of registering the specific β activity of an aqueous medium with increased turbidity is examined. The basic parameters of the device are reported. (tr-auth)

9625 SENSITIVITY OF THE RADIOMETER 2522-02 DURING THE MEASUREMENT OF THE SPECIFIC ACTIVITY OF AQUEOUS SOLUTIONS AND GASES. Artemenkova, L. V.; Zhdanova, N. F.; Lapshin, V. I. Yadern. Priborostr.; No. 14, 121-7(1971). (In Russian).

The results of the experimental investigation of the dependence of the sensitivity of the 2522-02 (Yasen-111) β plastic scintillation detector for liquids on the maximum energy of the β spectrum during measurement of the specific activity of aqueous solutions and gases are reported. It was shown that the sensitivity of the device during measurement of the specific β activity of aqueous solutions varies from 1×10^7 to 7.2×10^9 (pulses · l) /(sec · curie) in the range of maximum β spectrum energy from 0.25 to 3.5 MeV and for gases the sensitivity is 10^{10} for ^{41}Ar, 7.5×10^9 for ^{85}Kr, 5×10^9 for ^{133}Xe, and 5.8×10^{10} for ^{227}Rn. (tr-auth)

9626 QUESTIONS OF THE PRODUCTION OF SURFACE BARRIER SEMICONDUCTOR DETECTORS RESISTANT TO CLIMATIC AND MECHANICAL EFFECTS. Zakharchuk, O. V.; Nikitin, B. A.; Sel'dyakov, Yu. P.; Fedoseeva, O. P. Yadern. Priborostr.; No. 14, 128-33(1971). (In Russian).

A method for increasing the stability of operation of ceramic surface-barrier semiconductor detectors, consisting in the deposition on its sensitive surface protective films of silicon monoxide, zinc sulfide, and tin dioxide, is examined. The mechanical stability of this deposit and the operation in the temperature range from −50 to +50°C as well as at 40°C and 95% humidity were investigated. (tr-auth)

9627 EFFICIENCY OF THE REGISTRATION OF THE GAMMA RADIATION OF GERMANIUM SEMICONDUCTOR DETECTORS. Pakhomov, E. E.; Pakhomova, A. L.; Polytsya, O. P.; Sel'dyakov, Yu. P.; Skakodub, V. A. Yadern. Priborostr.; No. 14, 134-42(1971). (In Russian).

Questions concerning the efficiency of the registration of γ radiation by germanium semiconductor detectors were examined. On the basis of the investigation of a large quantity of domestic germanium semiconductor detectors, prepared according to three technologies, the dependence of the efficiency on the thickness and volume of the sensitive zone was determined. The empirical dependencies for the determination of the volume of the sensitive zone according to the value of the efficiency are cited. It is shown that the number of pulses at the peak of complete absorption is basically determined by the Compton transfer. (tr-auth)

9628 DETECTOR WITH CONTINUOUS DYNODES FOR REGISTRATION OF CHARGED PARTICLES. Ainbund, M. R.; Kovalenko, V. G.; Kolosov, Yu. A.; Polenov, B. V. Yadern. Priborostr.; No. 14, 160-5(1971). (In Russian).

The basic parameters and characteristics of the new channel electron multiplier with inlet window surface of ~0.1 cm^2 are reported. Its parameters are compared with known tubular channel multipliers. (tr-auth)

9629 ORGANIC SOLUTION SCINTILLATOR. Birks, J. B. (to Nuclear Enterprises Ltd.). British Patent 1,286,622. 23 Aug 1972. Filed 22 Aug 1968.

An improved organic scintillator is described consisting of an aromatic polymer solvent carrying a concentration of at least 10 g/l of a solute having a fluorescence decay time not exceeding 2 ns and a fluorescence quantum yield of the order of unity, such that the scintillator has a characteristic scintillation pulse width at half maximum scintillation intensity not exceeding 2 ns. Graphs are shown of the scintillation response functions of various scintillators, represented by the variation of scintillation intensity with time following instantaneous excitation. The solvent may comprise polystyrene, poly(vinyltoluene), or poly(vinylxylene), or mixtures or copolymers thereof, and the solute may comprise 2-phenyl-5-(4-biphenylyl)oxadiazole (PBD), an alkyl derivative of PBD, a substituted aligophenylene, diphenylstilbene, or a mixture thereof. (UK)

9630 MODIFIED SCINTILLATION CELL FOR THE DETERMINATION OF RADON IN URANIUM MINE ATMOSPHERE. Kristan, J.; Kobal, I. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Health Phys.; 24: No. 1, 103-4(Jan 1973).

Two modified scintillation cells have been made for the determination of radon which require simple sampling and which have adequate accuracy for field measurements. The direct α scintillation method is used as most convenient but the commercially available scintillation cells were found inadequate for rough mine conditions. Frequently there was loss of vacuum during transport and the evacuation procedure was cumbersome. In the new cell described two tubes are used so that air is sampled by pumping it through the cell by a hand pump. The photomultiplier tube voltage is 1000 V, counting time 5 to 15 min, background 0.2 to 0.5 cpm and the total error of measurement about 5%. The cell constants range from 0.47 to 0.63 cpm/(pCi/l). (UK)

9631 METHOD OF RECORDING HIGH ENERGY PARTICLES USING SOLID BODIES. Borshkovskii, I. A.; Volovik, V. D.; Zalyubovskii, I. I.; Kobizskoi, V. I. (Kharkov State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 8, 1791-4 (Aug 1972). (In Russian).

An apparatus is described for studying the excitation of ultrasonic waves during the passage of fast electrons through metal. A beam of electrons with energies $E_0 \leq 250$ MeV was directed onto a metal plate 0.2 cm thick which rested in an acoustic and electrostatic screen. A detector of ultrasonic vibrations was fastened to the metal plate. This and other sensors produced signals which were sent to an oscilloscope. The amplitude of the ultrasonic vibrations from the metal plate was measured as a function of the total number of electrons falling on the metal, which was alternatively made of Pb, Cu, stainless steel, or duraluminum. (K.S.W.)

9632 DETECTION CROSS SECTION OF A LEAD-LOADED PLASTIC SCINTILLATOR FOR SCATTERED γ RADIATION CONSIDERING THE DETECTOR THRESHOLD. Schaarschmidt, A.; Duerner, H. (Univ., Frankfurt am Main). Nucl. Instrum. Methods; 105: No. 3, 497-504(1972). (In German).

The intrinsic detection cross section of a 5% lead loaded cylindrical plastic scintillator (diameter = height = 3.4 cm) for multiply scattered γ-radiation is calculated in different approximations, taking into account the angular dependence of the scattered radiation and the bias level of the connected energy discriminator; γ-energy range 10−200 keV, bias level range 0−20 keV. (auth)

9633 COMPUTER SIMULATION OF NUCLEAR REACTIONS IN PHOTOEMULSIONS. Linetskii, A. R.; Lyubarskii, G. Ya.; Makarovskii, E. L. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 486-8(Mar 1972). (In Russian).

An algorithm and program were developed for simulating reactions of heavy ions. Events were simulated with neglect of measurement errors. Artificial errors in measurements were obtained by the method of statistical examination. The program was used for working out the requirements of a semiautomatic microscope under design and also for testing the algorithm stability of the program for geometrical reconstruction of the event. The results obtained after simulating the reaction program helped to improve the methods for nuclear photoemulsion measurements. (auth)

Radiation Dosimeters

9634 (BNL-17298) PORTABLE MIXED RADIATION DOSE EQUIVALENT METER. Kuehner, A. V.; Chester, J. D.; Baum, J. W. (Brookhaven National Lab., Upton, N. Y.). 26 Oct 1972. 22p. (CONF-721203-5). Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A portable instrument has been developed which measures both absorbed dose and total dose equivalent rates over 6 orders of magnitude. It is based on a 20 cm diameter modified Rossi-type tissue equivalent linear energy transfer (L) spectrometer. The detector is sealed for up to six months with gas purity maintained by means of a desiccant. Detector microphonics are avoided by using a Benjamin-type electrode structure. Dose equivalent values are obtained by means of a simple electrometer plus biased amplifier system. This system uses the detector as an ion chamber with gas gain, and at the same time as a proportional counter. The total current from the detector is proportional to absorbed dose. Two biased amplifiers give additional gain to pulses from particles with L's greater than 3.5 keV/μ. These weighted pulses, when added to the current measurement, yield an output proportional to dose equivalent. An internal alpha source permits several calibration checks to be made without external sources or equipment. When tested with monoenergetic neutrons and neutrons plus gammas, the instrument's errors have been less than ±12%. A recent application of the instrument has been to measure the natural background radiation profile at elevations up to 60,000 feet. For this measurement it was adapted for automatic data recording using two voltage to frequency converters and a register which prints the integral doses every 2 minutes. In this form it is capable of monitoring dose rates over 3 decades without range switching. (auth)

9635 (CONF-720411-5) ELECTRON DOSIMETRY USING CHALKLEY-McLAUGHLIN DYE-CYANIDE THIN FILMS. Eisen, Harvey; Rosenstein, Marvin; Silverman, Joseph (Maryland Univ., College Park, National Bureau of Standards, Washington, D. C.). 1971. 17p. (SM-160/56).

From Symposium on dosimetry techniques applied to agriculture, industry, biology, and medicine; Vienna, Austria (17 Apr 1972).

Experimental depth-dose distributions were determined for broad beams of 2.00-MeV electrons incident on polystyrene, aluminum, copper, tin, gold, and several two-layer slab absorbers. Data were obtained for both semiinfinite and finite homogeneous absorbers at incident beam angles ranging from 0 (normal incidence) to 75 degrees. Radiochromic dye-cyanide films were used as solid-state cavity dosimeters, with an experimental reproducibility of ±6 percent (2σ). The stopping power ratio necessary to convert from film dose to absorber dose was evaluated several ways. Depth-dependent stopping power ratios, obtained by accounting for the changing electron energy spectrum with absorber depth by two methods, were compared with a constant stopping power ratio for each material. The difference between the constant ratio and a depth-dependent ratio was 1 to 2 percent for aluminum, 3 to 5 percent for copper, 3 to 7 percent for tin, and 3 to 8 percent for gold. The data demonstrate the decrease in the depth-dose distribution and the total absorbed dose in finite slabs as compared to equivalent layers in semi-infinite slabs. The effect of the atomic number of the absorber and the angle of beam incidence on the shape of the energy deposition profile is also demonstrated. The data for the two-component slab absorbers illustrate the modification of the depth-dose profile in a finite slab of material if a different material is placed adjacent to it. From the dose received by a film placed at the interface, the surface doses at that position were estimated using the material-to-film stopping-power ratio appropriate for each material. The data are compared to the theoretical depth-dose profiles obtained using Monte Carlo transport codes. The agreement is generally between 5 to 10 percent for homogeneous cases and in most cases better than 10 percent for the two-component cases. (auth)

9636 (CONF-720701-(Absts.), pp 58-9) DOUBLE SPECTROMETER "BILL" WITH SECTOR FIELDS FOR CONVERSION ELECTRON MEASUREMENTS AT THE HFR-ILL IN GRENOBLE. Maier, B. P. K.; Mampe, W.; von Egidy, T. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9637 (CONF-720701-(Absts.), pp 66-7) GAMMA BAND-FILTER SPECTROMETER FOR NEUTRON CAPTURE STUDIES. Geinoz, D.; Kern, J. (Univ., Fribourg, Switzerland). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9638 (CONF-720701-(Absts.), pp 106-7) HIGH RESOLUTION FAST NEUTRON SPECTROMETRY. Shalev, S.; Cuttler, J. M.; Dagan, Y. (Technion, Haifa, Israel). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9639 (CONF-720701-(Absts.), pp 118-19) ABSOLUTE λ-RAY EFFICIENCIES OF THREE STANDARD TYPE Ge(Li) DETECTORS USED IN THERMAL NEUTRON CAPTURE REACTION STUDIES. Hassan, A. M.; Seyfarth, H.; Hrastnik, B.; Delang, W.; Goettel, P. (Kernforschungsanlage, Juelich, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9640 (KFKI-72-60) TWO CODES FOR EVALUATION OF NUCLEAR ACCIDENT DOSIMETRY SYSTEM. Zarand, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 15p. Dep. NTIS (U. S. Sales Only).

Two computer codes written for evaluation of nuclear accident dosimeters (NAD) based on activation detectors are described. The codes compute and plot kerma, neutron dose due to H(n,γ) reaction, neutron dose due to recoils, and neutron fluence along with other quantities useful in nuclear accident dosimetry. (auth)

9641 (SGAE-2037) MEASUREMENTS BY FLUOROCARBON-DOSIMETRY. Proksch, E.; Gehringer, P. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf, Institut fuer Chemie). Sep 1972. 7p. Dep. NTIS (U. S. Sales Only).

A fluorocarbon dosimeter based on measuring the production of F-cyclohexane (C_6) from irradiated F-methylcyclohexane (C_7) by gas chromatography is described. The response is nonlinear, independent of the dose rate, almost independent of temperature, and independent of the presence of oxygen. The response to fast neutrons is lower than for gamma radiation, and the pure gamma dose may be deduced with minor corrections for the fast neutron contribution. (W.H.K.)

9642 INDIVIDUAL DOSIMETER-RADIOMETER. Babichenko, S. I.; Karpinskii, I. P.; Pustavait, R. M. Yadern. Priborostr.; No. 15, 85-93(1971). (In Russian).

The operating principles and electrical circuits of the proportional counter for gamma dosimetry are described. The basic design and operational characteristics of the device are given. (tr-auth)

9643 BETA CALIBRATION OF RADIATION SURVEY INSTRUMENTS AT PROTECTION LEVELS. Owen, B. (National Physical Lab., Teddington, Eng.). Phys. Med. Biol.; 17: No. 2, 175-86(Mar 1972).

Beta ray dose rates at protection levels from sources of ^{90}Sr + ^{90}Y, ^{204}Tl and ^{147}Pm were measured in units of "millirads in air/hour" with a statistical uncertainty of ±2% or less and an estimated uncertainty of ±4% or less, using a specially designed thin-walled, parallel-plate ionization chamber. The measured dose rates from these sources were used to calibrate two different types of survey instruments (an end-window Geiger-Mueller monitor and a large volume ionization chamber monitor) with a statistical uncertainty of ±6% or less, and an estimated uncertainty of ±9% or less. (auth)

9644 PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON LUMINESCENCE DOSIMETRY, RISOE, DENMARK, OCTOBER 11-14, 1971. Mijdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971). 443p. (RISO-249(Pt.1); CONF-711026).

Thirty papers are presented arranged according to the following subjects: Mechanism of thermoluminescence, TL instrumentation, and improved TL materials. Separate abstracts are included for all papers. (Denmark)

For abstracts of individual papers see: 9645-9674.

9645 INTERPRETATION OF RESOLVED GLOW CURVE SHAPES IN LiF(TLD-100) FROM 100 TO 500°K. Podgorsak, E. B.; Moran, P. R.; Cameron, J. R. (Univ. of Wisconsin, Madison). pp 1-8 of Proceedings of the Third International Confer-

ence on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Each glow peak of LiF(TLD-100) in the temperature range from 100° to 500°K displays a shape, peaking temperature dependence on heating rate, and lack of peaking temperature dependence upon total light output which are in detail as predicted by the most simple thermally activated kinetics in the first order Randall–Wilkins limit. However, the glow curve breadth is anomalously large at low temperatures and anomalously small at high temperatures. While physically reasonable, although improbable, mechanisms might explain the larger breadths, there seems to exist no physically reasonable direct mechanisms to explain the narrower breadths. An indirect explanation is proposed in which the activation energy is itself slightly temperature dependent. How this effect explains the observed results is discussed and other implications are considered. (auth)

9646 ANALYSIS OF THERMOLUMINESCENCE KINETICS OF CaF_2:Mn DOSIMETERS. Adam, G.; Katriel, J. (Israel Atomic Energy Commission, Beersheba). pp 9-15 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A new approach to the analysis of glow curves was used to study the kinetics of the thermoluminescence of CaF_2 : Mn dosimeters. Activation energies, frequency factors, and related parameters were obtained. The measurements were carried out on the M.B.L.E. thermoluminescence dosimeters using a PNH 801 reader in the temperature ranges 300–700°K. The computational aspects of the analysis are discussed, and the computer program performing the entire analysis using as an input the glow curve data is described in the appendix. (auth)

9647 INVESTIGATION OF THERMOLUMINESCENT LITHIUM BORATE GLASSES USING ELECTRON SPIN RESONANCE. Shearer, D. R. (St. Bartholomews Medical Coll., London). pp 16-40 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

The trapping centers involved in the thermoluminescence of lithium borate glasses were identified as holes trapped on bridging and non-bridging oxygens in the glass matrix. The results of isothermal annealing experiments indicate that the untrapping process occurs over a continuous spectrum of activation energies. The radiation induced E.S.R. signal from the glasses with a high alkali content decays fastest except for the anomalous behavior of the pure borate glass in which the signal disappears rapidly at room temperature. The addition of manganese chloride increases the decay rate and reduces the number of trapped holes. Manganese occurs in two sites in the glass lattice, and there is evidence of this in the thermoluminescent spectrum. This spectrum can be altered by the addition of other activators. Heavily manganese-doped glasses exhibit an additional glow peak at a higher temperature. This has been assigned to the transition $Mn^{3+} + e \rightarrow Mn^{2+} + h\nu$ which occurs on post-irradiation heating. A model is proposed for the thermoluminescent process in these glasses, and some suggestions for the improvement of crystalline lithium borate phosphors are advanced. (auth)

9648 SIMPLE THERMOLUMINESCENCE MODEL AND ITS APPLICATION IN THERMOLUMINESCENT DOSIMETRY. Abedin-Zadeh, R. (International Atomic Energy Agency, Vienna). pp 41-7 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A simple thermoluminescence model based on the concept of energy levels is presented. The number of traps and holes is assumed to be the same as the number of peaks of the glow curve. All relevant parameters of the model as transition probabilities and the energy depth of traps can be obtained from experiment. Furthermore, for LiF (TDL-100) phosphor the calculated glow curve and integrated light output as a function of post-irradiation annealing temperature and time is presented. (auth)

9649 EFFICIENCY VARIATIONS OF THERMOLUMINESCENT LiF CAUSED BY RADIATION AND THERMAL TREATMENTS. Spanne, P.; Carlsson, C. A. (Linkoeping Univ., Sweden). pp 48-57 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Some preliminary results of an investigation concerning the efficiency of thermoluminescent LiF are reported. The TL-efficiency was tested following various radiation and thermal treatments. It was found that both radiation sensitization and radiation damage increase with increasing predose and with decreasing LET of the predose radiation. Furthermore, both effects can be repaired by thermal treatment. Radiation damage was also found to increase if the predose followed by a thermal treatment was fractionated. It is easier to introduce and repair the sensitizing effect than the damaging effect of the radiation. (auth)

9650 CONTINUOUS MODEL FOR TL TRAPS. Watanabe, S. (Instituto de Energia Atomica, Sao Paulo, Brazil); Morato, S. P. pp 58-77 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Analysis of glow curves in CaF_2: natural demonstrated that some glow peaks in this material do not obey the simple model of thermoluminescence proposed by Randall and Wilkins. In particular these peaks do not decay exponentially during isothermal heating; and, moreover, the peak positions change during such treatment. A model based on the superposition of two peaks was first proposed, wherein two closely spaced, unresolved peaks assumed to add to give the observed behavior. The calculations revealed that this model can reasonably well explain the isothermal decay curves, but not the isothermal change in the peak position. As a result, a second model was developed based on a narrow, continuous distribution of trap depth, thus modifying the model of Randall and Wilkins which is based on only one distinct trap depth. This second model, which supposes a Gaussian distribution for the trap depths, was used to explain the behavior of two glow peaks in natural CaF_2, giving satisfactory fits for the glow curve, for the isothermal decay, and for the isothermal change in the peak position. The application of this model also enables calculation of the trap parameters, which had not been previously accomplished. Analysis based on this continuous model was also extended to similar behavior of 280°C and 370°C peaks in the glow curve of dosimetric LiF : Mg. Isothermal decay and isothermal change in the position of these peaks were measured for this material. (auth)

9651 INFLUENCE OF HYDROXIDE IMPURITIES ON THERMOLUMINESCENCE IN LITHIUM FLUORIDE. DeWerd, L. A.; Stoebe, T. G. (Univ. of Washington, Seattle). pp 78-89 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Crystals diffused with OH ions show variations in thermoluminescent (TL) output with the concentration of OH ion complexes present in the crystal. The results show a decrease in TL intensity with an increase in the concentration of hydroxide ions, a change in the TL glow curve, and an absence of supralinearity in the presence of a large amount of OH ion complexes. From infrared absorption studies, the OH ion is found to complex with Mg^{2+}-cation vacancy dipoles. The decrease in TL sensitivity is caused by these OH ion complexes, which eliminate the Mg^{2+}-cation vacancy dipoles and dipole complexes from participating as traps in the luminescent process. The observed glow curve shapes are dependent upon the concentration of dipoles and dipole complexes, as modified by interactions with hydroxide ions. OH ion complexes can act as deep electron traps having a large capture cross section; the supralinearity decreases depending on the number of these complexes present. These results are consistent with non-luminescent trap of supralinearity. (auth)

9652 INFLUENCE OF OH ANION ON THE THERMOLUMINESCENCE YIELDS OF SOME PHOSPHORS. Nakajima, T. (National Inst. of Radiological Sciences, Chiba, Japan). pp 90-104 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Effects of the OH anion on the thermoluminescence sensitivity of LiF, CaF_2, BeO, Mg_2SiO_4 (Tb), and $CaSO_4$ (Tm) crystals were studied. When OH anions were doped in the crystals through thermal treatment in an atmosphere of water vapor, the sensitivity of the oxide crystals such as BeO and Mg_2SiO_4 was scarcely affected, but that of the non-oxide crystals was considerably decreased. The effect of illumination on the radio-thermoluminescence of the irradiated $CaSO_4$ (Tm) is slight, but it is evidently observable on that of the irradiated Mg_2SiO_4 (Tb). Influence of irradiating temperature on the response is scarcely detectable in the temperature range from 0°C to 40°C. (auth)

9653 ABNORMAL THERMOLUMINESCENCE FADING CHARACTERISTICS. Wintle, A. G.; Aitken, M. J.; Huxtable, J. (Oxford Univ.). pp 105-31 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

In some minerals and some samples of archaeological pottery there is significant fading of the TL event in the 400°C–500°C region of the glow-curve; this is for overnight storage at room temperature, following artificial irradiation. The minerals studied include orthoclase, labradorite, microcline, andesine, and mullite. In some cases the fading is not markedly reduced even if the storage temperature is −18°C, suggesting that the effect is due to a "non-thermal" mechanism. The fading in mullite and in the dosimetry phosphor CaF_2 : Mn is in this category. (auth)

9654 FADING IN THERMOLUMINESCENT DOSIMETRY. Spurny, Z.; Novotny, J. pp 132-45 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Fading in thermoluminescence dosimetry is discussed in general and particularly in a glass, LiF, CaF_2, Al_2O_3, and $CaSO_4$ phosphors. Special attention and experimental investigation are focused on "anomalous fading," when the TL signal of a certain phosphor with a relatively high peak temperature (T_M) decays with storage time at room temperature. Based on thermoluminescence, absorption spectroscopy, and delayed isothermal luminescence measurements a model of a trap is suggested and fading explained. (auth)

9655 EFFECTS OF DEEP TRAPS ON SUPRALINEARITY, SENSITIZATION, AND OPTICAL THERMOLUMINESCENCE IN LiF TLD. Sunta, C. M.; Bapat, V. N.; Kathuria, S. P. (Bhabha Atomic Research Centre, Bombay). pp 146-55 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A glow curve study of LiF samples from room temperature to 550°C using a linearly programmed heating system showed 10 glow peaks namely at about 75, 100, 135, 170, 190, 225, 250, 285, 310, and 395°C. The exposure response of LiF TLD was studied after annealing at 280, 350, and 400°C subsequent to a high gamma exposure. The observations obtained were used to examine the two models of supralinearity and sensitization, namely, (1) the early saturating competing deep trap model of Suntharalingam and Cameron and (2) the interacting track model of Claffy, Klick, and Attix. Studies on photostimulated glow peaks led to the conclusion that the observed glow peaks are due to untrapping of electrons. (auth)

9656 SUPRALINEARITY AND SENSITIZATION. Jain, V. K.; Sasane, J. B. (Bhabha Atomic Research Centre, Bombay). pp 156 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

LiF (TLD-100) and $Li_2B_4O_7$ show supralinear response above exposures of about 1000 R and 200 R respectively. Further LiF (TLD-100) can be sensitized by giving high exposures and annealing at 280°C for one hour. No such sensitization is observed in $Li_2B_4O_7$. The thermoluminescent phosphors available fall into two categories, namely low Z and high Z. LiF and $Li_2B_4O_7$ belong to the former, and CaF_2, $CaSO_4$, etc. belong to the latter category. The high Z phosphors are in general and order of magnitude more sensitive than the low Z phosphors. It is, therefore, suggested that in the high Z phosphors track interactions take place even at low exposures. In the case of low Z phosphors, however, there is no track interaction at low exposures. As the exposure increases, the track interactions start taking place and the response becomes supralinear. Further in LiF during the process of TL measurement or the 280°C annealing the filled peak 4 traps are emptied and converted to peak 5 traps. This conclusion is reached by observing that peak 4 is absent in the glow curve of the sensitized LiF. In $Li_2B_4O_7$ no such phenomenon occurs and, therefore, no sensitization is observed. To explain the difference between the sensitization on the basis of total TL measurement and peak 5 height measurement, it is suggested that the luminosity of peak 5 centers is more than that of peak 4 centers. (auth)

9657 RE-ESTIMATION OF DOSE IN LiF. Linsley, G. S.; Mason, E. W. (National Radiological Protection Board, Glasgow). pp 157-63 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A method for dose re-estimation with TLD-700 LiF is described using a series of unresolved thermoluminescent glow peaks centered around 300°C for a heating rate of 10°C/sec. The method involves a normal read-out cycle to 240°C followed by a second read-out to 370°C. The cut-off at 240°C is critical and an expression was developed relating the cut-off temperature Tc with the areas under each peak. In re-estimating dose, the supralinear dose versus intensity relationship of the "300°C" peak has to be taken into account. For virgin TLD-700 LiF doses as low as 5 rads can be re-estimated using the method. A method of enhancing the re-estimation sensitivity by using sensitized phosphors is discussed. This permits the re-estimation of doses of about 1 rad. (auth)

9658 PROPERTIES OF SOME DEEP TRAPS IN LITHIUM FLUORIDES. Mason, E. W.; Linsley, G. S. (National Radiological Protection Board, Glasgow). pp 164-84 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A thermoluminescent glow peak was observed in irradiated TLD-700 LiF at about 300°C for a heating rate of 10°C/sec. The peak consisted of at least three components. For absorbed doses of the order of 10 rads the peak was typically about 1% of the intensity of the 210°C peak, but became much more prominent at large doses. The dose versus TL intensity curve for the "300°C" peak was supralinear up to at least 10^5 rads. It is suggested that the trap concentration was actually increased by the radiation. The results of thermal annealing experiments are explained in terms of the formation of clusters of impurity atoms. This process was particularly prominent in the temperature range 100°C to 200°C. Annealing in this range resulted in a simultaneous increase in the "300°C" trap concentration and a decrease in the number of 210°C traps. It is postulated that the formation of clustered impurities resulted in the destruction of 210°C traps, but gave rise to an increase in the density of the crystal defects associated with the "300°C" traps. Observed departures from first-order kinetics in isothermal decay experiments are explained in terms of the temperature instability of the "300°C" traps and the possible effects of impurity atom agglomeration at temperatures close to 200°C. Optical experiments revealed that the "300°C" traps are occupied by electrons. The "300°C" traps distinguished from another deep trap which also bleached with F-band light. At this stage it is not possible to decide conclusively which of these is the F-center. (auth)

9659 POSSIBLE ELIMINATION OF THE ANNEALING CYCLE FOR THERMOLUMINESCENT LiF. Webb, G. A. M.; Phykitt, H. P. (Teledyne Isotopes, Westwood, N. J.). pp 185-208 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

The standard annealing cycle in thermoluminescent lithium fluoride has three components. First in maintenance at a high temperature, followed by cooling to 80°C and maintenance for 24 hours. An attempt was made to replace all these components by modifying the heating cycle during read-out. The modified cycle has four stages. Pre-heat for 12 seconds; read-out at a fixed temperature for a further 12 seconds; anneal at a high temperature

for 18 seconds; cool rapidly and reproducibly in a nitrogen gas stream. Integration of signal is carried out only during read-out, the other three stages are solely for annealing. The high temperature anneal zeroes the dosimeters, the cooling is more reproducible and the pre-heat bleaches out the low temperature peaks before integration commences. A new read-out instrument based on these principles is described. The high temperature anneal leaves less than 0.03% residual signal. The reproducible cool rate brings sensitivities of different batches of dosimeters within ±5% by cycling once through the read-out cycle. The performance of the pre-heat was studied by glow curve analysis and by fading studies. The results of 100 re-use cycles on LiF dosimeters are given, together with results for other phosphors. (auth)

9660 SIGNIFICANT CHANGES IN TLD READINGS PRODUCED BY AC HEATER CURRENTS. Saunders, J. E. (Ontario Cancer Treatment and Research Foundation, Hamilton). pp 209-25 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Variations of up to 9 percent in the light-source readings of a Conrad model 5100B TLD reader were found to be caused by residual magnetic fields in the environment of the photomultiplier tube (PMT). These fields were induced by the final pulse of the preceding AC heater current. Depending on the direction of this pulse, the light-source reading was either increased or decreased. Further investigation revealed that the PMT sensitivity was also directly affected while the heater current was flowing with changes in sensitivity of up to 18 percent between current on and current off. These two effects were investigated in detail for two PMT's, an EMI 6097S and a Centronics VMP 11/44K. The effects depended on the orientation of the PMT, the cathode potential, the magnitude of the heater current, and the magnetic shielding around the PMT. It was found that the most satisfactory method of reducing these effects was to increase the distance between the PMT and the heating element to 9 cm with a light-pipe between to maintain the efficiency of the system. (auth)

9661 PHOTON COUNTING AS APPLIED TO THERMOLUMINESCENCE DOSIMETRY. Schlesinger, T. (Israel Atomic Energy Commission, Yavne); Avni, A.; Feige, Y.; Friedland, S. S. pp 226-36 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

The technique of photon counting was applied to thermoluminescence dosimetry. A comparison was made between the sensitivity, accuracy, and signal to noise ratio obtained with a system based on this technique and a standard dc recording system. Readings could be made at least down to 5 mR with a standard deviation of about 12% over 10 readings as compared to 25 mR with a standard deviation of 50% for the same number of readings with the standard dc recording system. At 25 mR the signal to noise ratio for the new system was 1.3 as compared to 0.15 for the standard system. Refinements of apparatus and techniques are expected to produce further improvements. (auth)

9662 DOSIMETER AND READER BY HOT AIR JET. Oonishi, H.; Yamamoto, O.; Yamashita, T.; Hasegawa, S. (Matsushita Electric Industrial Co. Ltd., Osaka). pp 237-48 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A new type of TLD instrument was developed, in which a dosimeter is heated by hot air injected from a nozzle. The main characteristics of the instrument are excellent owing to the following features of heating: (1) dosimeters can be conveniently heated without contacting the heat source; (2) radiation noise caused by radiations from the heated body is minimized, e.g., the pre-dose of the rod type dosimeter caused by radiation noise is below 30 μR; (3) the selected part of a dosimeter can be heated without heating other parts: holding part, numbering part, or other TL element in a composite dosimeter; (4) the dosimeter can be heated very quickly, e.g., a rod type dosimeter 2 mm in diameter and 12 mm in length can be heated to 350°C in 4–8 seconds. (auth)

9663 EMISSION SPECTRA OF VARIOUS THERMOLUMINESCENCE PHOSPHORS. Konschak, K.; Pulzer, R.; Huebner, K. (Technische Univ., Dresden). pp 249-54 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Measuring equipment for the continuous determination of the emission spectra of thermoluminescence is described. The emission spectra of LiF (Dohnalum 200 Ti), synthetical CaF_2 : Mn, and an Al_2O_3 ceramic are given. The influence of the absorbed dose on the emission maximum of CaF_2 is shown. The emission spectrum at the photostimulated thermoluminescence was investigated. (auth)

9664 SOME THERMOLUMINESCENT PROPERTIES OF QUARTZ AND ITS POTENTIAL AS AN ACCIDENT RADIATION DOSIMETER. McDougall, D. J. (Loyola Coll., Montreal). pp 255-76 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Both natural and artificial pressure and thermal effects may be of considerable importance in modifying the thermoluminescence of quartz. Static loading of the order of 1 kilobar may cause increased thermoluminescence in one peak, and impact loading of the order of 100 kilobars may decrease the height of the peak and increase the height of another. Cyclical loading can produce large increases in the emission. The maximum radiation sensitivity of the "radiation" peak occurs after annealing at 400°C. Below the 573°C crystallographic transition, high temperature peaks are annealed out, but reappear after annealing above the transition temperature. The variations in peak heights due to pressure and thermal effects are speculatively ascribed to changes in the concentrations of either lattice dislocations or oxygen defects, with metallic impurity ions playing a minor role. The widespread occurance of quartz in sands, rocks, and concrete makes it a potentially useful "accident" radiation dosimeter for approximate measurements, provided that certain conditions can be met. Pronounced shock or thermal events concurrently with or following the accident would seriously limit its usefulness. (auth)

9665 THERMOLUMINESCENT ENAMELS. Mihailovic, M. (Univ. of Ljubljana, Yugoslavia); Kosi, V. pp 277-89 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

About thirty varieties of TL enamels were developed and their dosimetric properties investigated. Six varieties of TL enamels and their properties are presented. Some of them have favorable dosimetric characteristics: (1) They have a simple glow curve, (2) are linear up to 5.10^4R ^{60}Co γ-ray exposure, and (3) have no fading. The response at 22 keV_{ef} is fifty percent higher than at 1.25 MeV. Pre-irradiation annealing experiments at 200°C, 260°C, 320°C, and 400°C were performed. The sensitivity of the boro-alumino silicate glass type with lithium content depends appreciably on the temperature of the pre-irradiation annealing. However, the enamels of boroalumino silicate type without lithium, but with melt in grains of lithium silicate, are rather independent of the temperature. The influence of pre-irradiation annealing at 260° and 400°C on fading characteristics was investigated. The experiments showed that pre-irradiation annealing has an influence on fading. (auth)

9666 THERMOLUMINESCENT PHOSPHORS BASED ON BERYLLIUM OXIDE. Yasuno, Y.; Yamashita, T. (Matsushita Electric Industrial Co. Ltd., Osaka). pp 290-304 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Alkaline ions: M^{+1}(Li^{+1}, Na^{+1}, K^{+1}), trivalent ions: M^{+3}(B^{+3}, Al^{+3}), and tetravalent ions: M^{+4}(Si^{+4}, Ge^{+4}) in BeO were found to play a part in the thermoluminescent ability of BeO. Controlled ceramics samples artificially doped with such ions were prepared by the sintering method. In BeO : M^{+1} a strong TL showing a main peak at 180°C was observed. Additional doping of M^{+3} besides M^{+1} caused decrease of the main peak, but it did not disappear, moreover, it dominated in every sample, BeO : M^{+3} or BeO : M^{+4}, even if the intensity was small. At a higher exposure level (supralinear region), another peak dominated: 230°C in BeO : M^{+1} (over 100R), 210°C in BeO : M^{+3} (over 40R), and 190°C in BeO : M^{+4} (over 100R).

These peaks also appeared by light stimulation of the samples once exposed to high dose and annealed. Among the samples examined, BeO : M^{+1}, in particular BeO : Na, are excellent for TLD: (1) a linear response extending from 2mR to 1000R in BeO : Na, and from 1mR to 2000R in BeO : Li; (2) little fading of the 180°C peak (initial fading of 5% in the first day and subsequent fading of 2% in the next 30 days). (auth)

9667 STUDY OF SILVER, IRON, COBALT, AND MOLYBDENUM AS LITHIUM BORATE ACTIVATORS FOR ITS USE IN THERMOLUMINESCENT DOSIMETRY. Moreno y Moreno, A.; Archundia, C.; Salsberg, L. (Univ. Nacional Autonoma de Mexico, Mexico City). pp 305-31 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

The behavior of silver, iron, cobalt, and molybdenum as $Li_2B_4O_7$ activators for its use as thermoluminescent dosimetric material was examined. The existence of a time persistent fundamental peak at 140°C and 210°C, as well as the rapid disappearance of the 90°C peak indicated silver to be the most reliable. Three techniques for silver activated lithium borate preparation are discussed. Selection of the best method in accordance with the spectrum time variation and thermoluminescent response for 0.10, 0.30, 0.40, and 0.50% silver concentration as silver nitrate is presented. The material showed the same spectral responses from 60 kV to 220 kV, 20 mA X-rays, and linear thermoluminescent response up to 840 kR exposure from a ^{60}Co gamma source. (auth)

9668 SINTERED TL DOSIMETERS. Niewiadomski, T.; Jasinska, M.; Ryba, E. (Inst. of Nuclear Physics, Krakow). pp 332-49 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A new method of preparation of solid LiF for dosimeters is described. Based on cold compressing and sintering of LiF powder it is simpler than single crystal growing used previously, allowing batches containing thousands of dosimeters to be produced with a precision better than ±5% S.D. The changes of TL properties of a few LiF phosphors were investigated during preparation by this new method. Compressing causes a significant loss of TL sensitivity and a change in the glow curve shape of all examined phosphors. The crystal defects responsible for these phenomena are annealed at higher temperatures. The dosimeters become semi-transparent, and their mechanical and TL properties are improved when sintered. In this way 4.5 mm dia 0.83 mm thick disks and 1.7 mm dia 4 mm long rods were produced. The properties of sintered dosimeters were compared with other solid-form LiF dosimeters. Sensitivity per rad end per milligram compared with that of TLD-100 powder was found to be: TLD-100 powder−1, sintered −0.27, Dohna-Lum LiF-200 Ti/GDR/powder−0.9, sintered−0.5, LiF : Mg, Ti/Institute of Nuclear Physics/micro-crystalline−0.9, sintered−0.57, TLD-100 high sensitivity extruded−0.44. The lowest detectable dose of sintered disks made of LiF : Mg, Ti is about 1 mrad and that of rods 5 mrads. Single crystal personnel dosimeters were replaced by sintered disks in March 1971 at the Institute of Nuclear Physics, Cracow. Some hundreds of these dosimeters are being tested in radiological clinics to check their usefulness. (auth)

9669 STUDIES ON THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE DOPED WITH VARIOUS ACTIVATORS. Robertson, M. E. A. (D. A. Pitman Ltd., Weybridge, Eng.); Gilboy, W. B. pp 350-6 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

"Pure" lithium fluoride with weak TL properties was doped with various activators and the glow curve structure of each sample examined. The combinations of activators produced samples with sensitivity comparable to commercially available LiF. The low temperature peaks in these samples were at a higher temperature than the light-sensitive low temperature peak in TLD-700, and preirradiation annealing at 80°C for 24 hours did not alter the glow curve structure. (auth)

9670 NEW TL LiF(NTL-50) WHICH IS UNNECESSARY OF ANNEALING ITS PROPERTIES ESPECIALLY FOR APPLICATION AND THE RESULTS OF SEVERAL PRACTICAL CASES. Naba, K. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Vienna). pp 357-79 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A new TL LiF was developed and named NTL-50. Its properties were studied with a view to practical application. The results were: (1) No change of TL response during exposure from −20°C to +40°C. (2) Annealing at 300°C × 3 min is sufficient without N_2 flow until 1,000 R previous exposure. For over 1,000 R previous exposure, annealing should be done at 300°C × 1 hr with N_2 gas flow. (3) Under 1 R measurement: N_2 flow is necessary. (4) Spurious luminescence can be eliminated by 110°C × 5 min preheating. The NTL-50 was tested in (I) Measurement of contamination: Quick and convenient measurement of surface, water and air H-3 contamination. a. Surface contamination after fire accident. b. Surface contamination under external γ rays. c. Surface contamination in waste disposal site. (II) Development of a new finger ring (Doppel Ring) and its application for glove box working. (III) Separate β and γ measurement from mixed radiation by TLD and fluoroglass dosimetry. (auth)

9671 THERMOLUMINESCENT RESPONSE OF NATURAL BRAZILIAN FLUORITE TO ^{137}Cs GAMMA-RAYS. Watanabe, S. (Instituto de Energia Atomica, Sao Paulo, Brazil). pp 380-91 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

For understanding of the supralinearity phenomenon and utilization of the fluorite in radiation dosimetry the thermoluminescent response of natural Brazilian fluorite to ^{137}Cs gamma-rays was studied. Virgin fluorite was pre-annealed at 580°C for ten minutes followed by 400°C for two hours and then irradiated to different exposures between 25 R and 1.2 MR. The response of glow peak II (pan temperature 180°C) is linear up to 3 kR, beyond which it becomes supralinear and finally saturates at about 300 kR. Under these conditions, the response of glow peak III (pan temperature 290°C) is not supralinear, and saturation is reached sooner, at about 100 kR. The correlation between supralinear response and sensitization was also studied. Samples irradiated to different exposures, as above, were individually annealed after irradiation for 15 minutes at 400°C and then exposed to 100 R. Peak III exhibited sensitized response above 3 kR previous exposure, whereas peak II demonstrated only slight sensitization and only near 100 kR previous exposure. Thus, sensitization is anti-correlated with supralinear response for these two peaks. Peak II was found to be sensitized, however, when the post-irradiation anneal was at 175°C instead of 400°C, and thus eliminated only peaks I and II, and not III. Also, supralinear response can be obtained from peak III when the virgin phosphor is annealed at 600°C for more than 10 minutes. These results are qualitatively explained by the model postulating competing traps, although model must be applied in a slightly altered form. Other existing models do not seem appropriate. (auth)

9672 THERMOLUMINESCENCE OF NATURAL CaF_2 AND ITS APPLICATIONS. Sunta, C. M. (Bhabha Atomic Research Centre, Bombay). pp 392-409 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

Thermoluminescence glow curves were recorded from room temperature to 550°C for a number of natural CaF_2 samples. Light-green-transparent crystalline specimens were found to possess maximum sensitivity to γ ray exposure and to be most suitable for the dosimetry of ionizing radiations as well as ultraviolet rays. The spectrum of the thermoluminescent light consists of a number of sharp lines spread in a wide spectral range from ultraviolet to infrared. Almost all of the emission lines can be attributed to one or other of the rare-earth impurities. It is proposed that the thermoluminescence mechanism in CaF_2 involves the release of holes from lattice centers and their recombination at the rare-earth impurity sites. A model of photostimulated thermoluminescence is presented. (auth)

9673 IMPROVEMENT OF SENSITIVITY AND LINEARITY OF RADIOTHERMOLUMINESCENT LITHIUM FLUORIDE.

Portal, G.; Berman, F.; Blanchard, P.; Prigent, R. (CEN, Fontenay-aux-Roses, France). pp 410-26 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A pre-irradiation thermal annealing of dosimeter standard grade lithium fluoride (TLD-LiF) is necessary to eliminate shallow traps which are relatively unstable, reducing the measurement accuracy. The origin of these traps was studied, and it was discovered that it was possible to delay their formation by Na incorporation, during the preparation process. So the importance of these low energy traps can be reduced to a minimum, and it is possible to eliminate them at the reading stage with a simple device. Also a new type of sensitized lithium fluoride is presented which is 3 to 4 times as sensitive as the current product and linear from 1 mrad to 10^4 rads. Sintered dosimeters, designed for personnel monitoring prepared from this new product, present a high sensitivity and a very low spurious triboluminescence signal, and can be read without nitrogen. (auth)

9674 FURTHER STUDIES ON THE DOSIMETRIC USE OF BeO AS A THERMOLUMINESCENT MATERIAL. Scarpa, G.; Benincasa, G.; Ceravolo, L. (CNEN, Casaccia, Italy). pp 427-43 of Proceedings of the Third International Conference on Luminescence Dosimetry. /Mejdahl, V. (ed.). Risoe, Denmark; Danish Atomic Energy Commission (1971).

From third international conference on luminescence dosimetry; Risoe, Denmark (11 Oct 1971). See RISO-249(Pt.1); CONF-711026.

A study was carried out on commercial ceramic beryllium oxide disks with an impurity of 0.5% and an effective atomic number of 7.1. The proposed annealing procedure (5 minutes at 600°C) was selected on the grounds of best reproducibility of read-outs. The glow curve showed two main peaks, the second one saturating quickly for exposures higher than 1000 R. The temperature of the first peak varied between 220 and 240°C depending on dose level; its area was linear with dose till about 100 R, then supralinear. The reproducibility of the peak area from exposure to exposure of a given sample varied between 0.7 and 2.4% in the range from 0.5 up to 100,000 R; slightly less accurate results have been obtained using the peak-height method and in the low-dose region. The dependence of response on photon energy was not very marked, the maximum value being 1.25 (^{60}Co = 1.00) at about 100 keV, i.e. even lower than that of LiF. The fading in darkness was rather slow, attaining a value of about 8% in 2 months. During the third and fourth weeks an apparent slight recovery took place. The response to uv light of irradiated BeO, after read-out, was also investigated; using this method a reassessment of the previous radiation dose is feasible, even if not very accurate. (auth)

9675 OPTIMUM DATA REDUCTION OF COMPLEX MOESSBAUER SPECTRA: $^{129}I_2$. Robinette, Rosalie; Cosgrove, J. G.; Collins, R. L. (Univ. of Texas, Austin). Nucl. Instrum. Methods; 105: No. 3, 509-13(1972).

An optimal method of extraction of hyperfine parameters from complex Moessbauer spectra is presented for $^{129}I_2$. Rather than fit the data to twelve line positions, and then fit these line positions to theory to derive the hyperfine parameters, we proceed directly to calculate a theoretical spectrum from an initial guess of the parameters. The parameters are then optimized simultaneously by a least-squares fit to the data, with the required derivatives with respect to each parameter determined numerically rather than analytically. Data for $^{129}I_2$, obtained at 77°K on a laser-calibrated spectrometer, are used to illustrate the method. The results are: at 77°K, $e^2qQ = -1526 \pm 4$ MHz, isomer shift = $+1.019 \pm 0.011$ mm/s relative to ZnTe at 77°K, $\eta = 0.180 \pm 0.006$, $\Gamma_h = 1.385 \pm 0.0022$ mm/s, and $Q^*/Q = 1.2385 \pm 0.0011$. For $^{127}I_2$, e^2qQ translates to -2180 ± 7 MHz. (auth)

9676 USE OF SELECTIVE FILTERS IN X-RAY ANALYZERS WITH SEMICONDUCTOR DETECTORS. Baldin, S. A.; Ioannesyants, L. M. Yadern. Priborostr.; No. 14, 143-6(1971). (In Russian).

The possibility of increasing the sensitivity of x-ray analyzers with semiconductor detectors by using selective filters was examined. It was shown that during the analysis of Mo, the sensitivity threshold can be reduced 4 to 5 times. The characteristics, advantages, and disadvantages of the methodics of element analysis using selective filters jointly with semiconductor detectors are discussed. (tr-auth)

9677 INTEGRAL-PULSE IONIZATION CHAMBER. Babichenko, S. I.; Karpinskii, I. P.; Kryukova, I. N. Yadern. Priborostr.; No. 14, 166-71(1971). (In Russian).

A new form of detector for ionizing radiation—the integral-pulse ionization chamber, designed mainly for dosimetric measurements—was examined. The use of similar chambers makes it possible to simplify significantly the electronic circuit of dosimetric devices, noticeably to reduce their weight, overall dimensions, and power requirements. (tr-auth)

9678 THRESHOLD SENSITIVITY OF PHOSPHORS DURING MEASUREMENT OF THE SPECIFIC BETA ACTIVITY OF AQUEOUS SOLUTIONS. Beskorskii, A. I.; Goikhberg, E. Ya.; Kazanskaya, V. A.; Sokolov, A. D.; Fedorovskii, Yu. P. Yadern. Priborostr.; No. 14, 172-9(1971). (In Russian).

The results of calculated and experimental investigations of the threshold sensitivity of thermoluminescent and exoemission detectors made from the $CaSO_4$ luminophor during registration of the β activity of aqueous solutions of $^{90}Sr + ^{90}Y$ are reported. The construction and technology of the manufacture of the exoemission counter with a large sensitive surface are described. A block circuit of the measurement installation is given. It is shown that the threshold sensitivity of the detector is $q = 3 \times 10^{-8}$ curie/l for thermoluminescent detectors and $q = 6 \times 10^{-9}$ for exoemission detectors. (tr-auth)

9679 CHEMICAL DOSIMETRY METHODS FOR PULSED ELECTRON RADIATION. Pikaev, A. K. Usp. Khim.; 41: No. 9, 1696-1712(Sep 1972). (In Russian).

Commercial pulsed electron accelerators are surveyed with respect to the available energies, duration and maximum current. The common chemical dosimetric systems are reviewed: $FeSO_4$, Ce^{3+}, HCOOH, C_6H_6, $H_2C_2O_4$, CH_3OH, NaOH, H_2SO_4, etc. The products of radiolysis are discussed, and the advantages or disadvantages of each system are mentioned. (112 references.) (K.S.W.)

9680 RESPONSE OF NTA PERSONNEL NEUTRON MONITORING FILM WORN ON HUMAN PHANTOM. Oshino, M. (Univ. of California, Berkeley). Health Phys.; 24: No. 1, 71-80(Jan 1973).

NTA films worn on a human phantom were exposed to several neutron sources (average energies ranged from 0.7 to 4.4 MeV) and to stray neutrons of the Bevatron. Responses of NTA films were obtained in terms of proton track density per mrem, a convenient expression for dose equivalent evaluation in personnel neutron monitoring. The responses obtained were 3.9 t/cm^2-mrem for ^{252}Cf fission neutrons, 9.2 t/cm^2-mrem for PuBe neutrons, and 11.9 t/cm^2-mrem for Bevatron neutrons. The detectable limit of dose equivalent in personnel neutron monitoring with NTA films is statistically discussed. Consequently, it is found that the detectable limit of Bevatron neutrons is 150 mrem when scanning 25 microscopic fields if a statistical error of 20% is acceptable. (auth)

9681 $4\pi-\beta$-SPECTROMETER USING Si(Li)-DETECTORS. Schmitz, B. M.; Farzine, K.; von Buttlar, H. (Ruhr-Univ., Bochum, Ger.). Nucl. Instrum. Methods; 105: No. 3, 427-30 (1972).

A $4\pi-\beta$-spectrometer is described which uses two cooled Si(Li)-detector diodes facing the radioactive source in a vacuum cryostat. Spectra are shown for ^{207}Bi and ^{137}Cs for a single detector and two detectors in sum as well as in anticoincidence operation. The advantages of each mode of operation are discussed. The extrapolation to an exact 4π-geometry is carried out for the case of ^{137}Cs. (auth)

Nuclear Spectroscopic Instrumentation

9682 (ARH-SA-134) AUTOMATIC RADIOACTIVE INVENTORY SYSTEM. Zimmer, W. H. (Atlantic Richfield Hanford Co., Richland, Wash.). Nov 1972. Contract AT(45-1)-2130. 35p. (CONF-721202-3). Dep. NTIS.

From Nuclear science symposium; Miami Beach, FL (6 Dec 1972).

The philosophy used in detector configuration design and small computer programming for an Automatic Radioactive Inventory System is presented. The range of application is nondestructive, low-density energy analysis from natural and fallout radiation in soils to high-level radiation in solid waste packages. The system consists of Ge(Li) and NaI(Tl) detectors for gamma spectral analysis. (auth)

9683 (CONF-720701-(Absts.), pp 40-1) CURVED CRYSTAL GAMMA-RAY SPECTROMETER AT THE GRENOBLE HIGH-FLUX REACTOR. Koch, H. R.; Schult, O. W. B.; Pinston, J. A.; Roussille, R.; Boerner, H. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

9684 (JINR-P10-6751) AUTOMATIC MICROPHOTOMETER ON-LINE WITH THE COMPUTER. THE SCANNING OF THE BETA-SPECTROGRAMS AND THE DATA PROCESSING. Vylova, L. A.; Zalite, V. A.; Iskhakov, G.; Levchanovskii, F. V.; Potempa, M.; Prikhod'ko, V. I.; Revenko, A. V.; Stakhura, Z.; Tsupko-Sitnikov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The system for automatic continuous photometric measurements is developed on the basis of a standard MΦ-2 microphotometer. The light flux passing a sample is registered by a photomultiplier. The photomultiplier output signal after ADC is fed to the computer memory directly. The maximal channel range which can be written during one scanning operation is 16.000. The speed of photometric operation is 4 mm/sec (80 points with the 0.05 mm step and 160 points with the 0.025 mm step). The system is used for the scanning of the spectrograms obtained from magnetic beta-spectrographs. (auth)

9685 (KFK-1604) A γ-SPECTROMETER WITH COMPTON SUPPRESSION FOR NUCLEAR STRUCTURE RESEARCH BY NEUTRON CAPTURE. Heck, D.; Fanger, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Mar 1972. 20p. (In German). (CONF-720340-1). Dep. NTIS (U. S. Sales Only).

From Meeting on nuclear physics and electronics in physics experiments; Berlin, Germany (20 Mar 1972).

The sensitivity of the anti-Compton spectrometer at Karlsruhe was considerably increased by using a more efficient Ge(Li)-detector and by a new arrangement of the multipliers. At an energy resolution of 1.60 keV the P/C ratio reaches 220 : 1 for the gamma rays of ^{137}Cs. A further improvement may be achieved by narrow collimated irradiation into selected portions of the Ge(Li)-detector. The effectiveness of the apparatus is demonstrated by two doublets in the capture γ-ray spectrum of ^{190}Os which are of some theoretical interest. (auth)

9686 (LA-5088) LEAST-STRUCTURE UNFOLDING CODE. Robba, A. A.; Veeser, L. R. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 10p. Dep. NTIS.

A computer code has been written to solve integral equations of the first kind, subject to constraints on the structure of the solution. The code has been tested by unfolding measured neutron and gamma-ray spectra. The unfolding method, least-structure analysis, is described briefly, and a listing of the computer program is given. (auth)

9687 (LUSY-7209) DESCRIPTION OF A PAIR SPECTROMETER USED TO STUDY THE SMALL ANGLE SCATTERING OF HIGH ENERGY PHOTONS. Paper 15. Jarlskog, G.; Joensson, L.; Pruenster, S.; Schulz, H. D.; Willutzki, H. J.; Winter, G. G. (Lund Univ. (Sweden). Dept. of Physics). Sep 1972. 12p. Dep. NTIS (U. S. Sales Only).

A magnetic pair spectrometer has been designed to detect and measure photons in the GeV region scattered into the angular range of 1 to 4 mrad with respect to a well collimated, high intensity bremsstrahlung beam. Since it was essential to know the scattering angle the design makes a reconstruction of the conversion point possible. The pair spectrometer was used in an experiment at DESY, Hamburg to study the small angle scattering of high energy photons by heavy nuclei (Delbrück scattering and photon splitting). (auth)

9688 (UUIP-785) LARGE IONIZATION CHAMBER USED AS AN ALPHA SPECTROMETER FOR U/Th DATING. Hoegberg, S. A. C.; Gustavsson, J. E. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 28p. Dep. NTIS (U. S. Sales Only).

A description is given of an ionization chamber for alpha particles. The instrument is intended to be used as a spectrometer for age determination with the U/Th-method. (Sweden)

9689 COMPARATIVE PULSE-HEIGHT ANOMALY FOR PROTONS AND ALPHA-PARTICLES IN SILICON SURFACE BARRIER DETECTORS. Kemper, K. W.; Fox, J. D. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods; 105: No. 2, 333-4(1972).

It was observed experimentally that the pulse height obtained from a Si surface barrier detector for 9.500 MeV incident alpha particles and protons is different by 56 ± 9 keV, with the alpha particle appearing to have the higher energy. This result indicates that Q value determinations obtained by comparing the energy of different particles can be seriously in error. (auth)

9690 POSITION SENSITIVE SURFACE BARRIER ARRAY TYPE DETECTOR. Hansen, N. J.; Henderson, D. J.; Scott, R. G. (Argonne National Lab., IL). Nucl. Instrum. Methods; 105: No. 2, 293-300(1972).

A position-sensitive array-type surface barrier detector system was constructed and mounted in the focal surface of the Argonne double focusing magnetic alpha-particle spectrometer. The array is 9'' long, and consists of 224 detector elements, each 0.040'' wide by 1'' high. The elements are made in blocks of 16 on single silicon crystals 0.640'' wide and 1'' long by evaporating the gold through a grid of parallel wires. The energy of the detected alpha particles is uniquely determined by the position of the detecting element in the array, and background rejection is accomplished by pulse height selection. The immediate availability of the data pulse makes possible coincidence counting experiments, which enhances the versatility of the instrument. The details of the fabrication and the analysis of the performance of the detector system are discussed. (7 figures) (auth)

9691 IN-BEAM AXIAL β-RAY SPECTROMETER FOR THE MEASUREMENT OF INTERNAL CONVERSION ELECTRONS. Picone, J. M.; Fitch, J. F.; Baker, J. W.; Hoffmann, G. W.; Moore, C. F. (Univ. of Texas, Austin). Nucl. Instrum. Methods; 105: No. 2, 377-9(1972).

An axial beta-ray spectrometer for in-beam internal conversion measurements is described. Spectra taken for electrons from p + ^{90}Zr reactions at 11.2 MeV bombarding energy demonstrate the high transmission and low background provided by this instrument. (2 figures) (auth)

9692 SPECIAL CRYOSTAT FOR MOESSBAUER EFFECT INVESTIGATIONS OF LATTICE DEFECTS AFTER LOW TEMPERATURE NEUTRON IRRADIATION. Rosner, P.; Vogl, W.; Vogl, G. (Technical Univ., Munich). Nucl. Instrum. Methods; 105: No. 3, 473-6(1972).

A cryostat for Mössbauer effect measurements after 4 K high dose neutron irradiation without warming up of the samples between irradiation and measurement is described. This makes it possible to investigate irradiation defects in the as-produced state with the Mössbauer effect. The cryostat can be cooled independently of the low temperature irradiation facility. The irradiated sample can be used as a Mössbauer source or absorber. (auth)

9693 COAXIAL-CYLINDER ELECTRON SPECTROMETER FOR BEAM FOIL EXPERIMENTS. Dietz, E.; Groeneveld, K. O.; Spohr, R.; Staudte, R. (Univ., Frankfurt am Main). Nucl. Instrum. Methods; 105: No. 3, 467-71(1972).

An electrostatic electron spectrometer for energies up to 10 keV, consisting of two coaxial cylinders, is described together with its data acquisition system. The spectrometer permits free access to both source and detector region, the distance between source (or detector) and spectrometer being 1 cm. This new design property is made possible by introducing potential shaping fringe plates of novel design. The spectrometer transmission or resolution can be adapted to the specific experimental needs by exchanging apertures. The spectrometer is protected from external fields by a magnetic shield integrated into its design. (auth)

9694 ANALYSIS OF GAMMA-RAY LINEAR POLARIZATION SPECTRA OBTAINED WITH A NaI COMPTON POLARIMETER. Turcotte, A. (Univ. of Montreal); Taras, P. Nucl. Instrum. Methods; 105: No. 3, 445-51(1972).

The main disadvantage of a NaI Compton polarimeter vis-à-vis a Ge(Li) polarimeter is its relatively poor resolution. Two methods of overcoming this difficulty are presented. The first one is a semi-analytical method which can usually be applied to up to three γ-rays present in an unresolved γ-ray peak. The second one consists in fitting to the peaks a gaussian shape superimposed on either a parabolic or linear background. Both methods are illustrated by the analysis of recent measurements in ^{37}Ar. (auth)

9695 USE OF ^{6}Li SEMICONDUCTOR SANDWICH SPECTROMETER FOR THE MEASUREMENT OF FAST-NEUTRON SPECTRA. Rickard, I. C. (Imperial Coll. of Science and Tech., London). Nucl. Instrum. Methods; 105: No. 3, 397-411 (1972).

The construction and properties of the lithium-6 semiconductor detector are discussed. The technique may be used to measure neutron spectra over the energy range (10 keV-6 MeV). Major sources of experimental error have been isolated, enabling improvements to be incorporated into the existing electronics system. The life-span of the detectors is severely limited by fast neutron radiation damage of the silicon diodes. The ^{6}Li cross-section has been remeasured to an accuracy of ±4% (one standard deviation). The method of background subtraction has been tested and found to be adequate. Fast neutron spectra have been measured in three ZEBRA assemblies in the energy range (10 keV-6 MeV) and their accuracies assessed. The experimental results are compared with results from competing experimental techniques and

with the theoretical predictions made using current methods and data. It is concluded that the results provide a sufficient overlap with existing techniques to give an accurate measurement of the fast-neutron spectrum above 1 MeV. (auth)

9696 GAMMA-RAY INTENSITY STANDARDS: THE REACTIONS $^{14}N(n,\gamma)^{15}N$, $^{35}Cl(n,\gamma)^{36}Cl$, AND $^{53}Cr(n,\gamma)^{54}Cr$. Loper, G. D.; Thomas, G. E. (Argonne National Lab., IL). Nucl. Instrum. Methods; 105: No. 3, 453-60(1972).

The relative and absolute intensities of γ-rays from thermal-neutron capture in ^{53}Cr, ^{52}Cr, ^{50}Cr and ^{35}Cl have been determined over the energy range 1.8-11 MeV. The absolute intensities were measured by a method in which transition intensities are compared with the well-known 100% intensity of the 7368-keV transition in ^{208}Pb. Detector-efficiency curves were computed from the previously reported relative intensities for transitions in $^{14}N(n,\gamma)^{15}N$ and in $^{53}Cr(n,\gamma)^{54}Cr$, and the good agreement between their shapes over a wide energy range suggests that both sets of intensities are reliable. (auth)

9697 GAMMA-RAY SPECTROSCOPY WITH PARTICULAR REFERENCE TO DETECTOR AND COMPUTER EVALUATION TECHNIQUES. Quittner, P. London; Adam Hilger Ltd. (1972). 111p.

Modern nuclear measuring instruments permit in one measurement the simultaneous collection of several hundred and sometimes even many thousands of different data, each containing valuable information. Efficient evaluation of such a large number of data requires the use of a computer. The main applications of computers in gamma-ray spectroscopy and the theoretical outline of the evaluation methods are described. The main features of gamma-ray spectra, spectrum generation, peak location, peak area calculations and weighted least-squares resolution of composite spectra for gamma-ray energy and intensity determination are discussed in detail. Practical applications are shown by such illustrative examples as decay curve analysis, activation analysis programs, sensitivity calculations and on-line coupled computers. (auth)

9698 GENERATION OF TIMING SIGNALS FOR THE NEUTRON TIME-OF-FLIGHT SPECTROMETER AT THE HAMBURG ISOCHRONOUS CYCLOTRON USING SCINTILLATION FOILS. Kellermann, H. J.; Klages, H. O.; Krause, H.; Langkau, R. (Univ., Hamburg). Nucl. Instrum. Methods; 105: No. 3, 493-6(1972). (In German).

The generation of timing signals by scintillation foils for the fast neutron time-of-flight spectrometer at the Hamburg Isochronous Cyclotron has been studied. (auth)

9699 USE OF Ge(Li) DETECTORS FOR RECORDING SOFT γ RADIATION ARISING FROM 14-MeV NEUTRON REACTIONS. Poyarkov, V. A.; Prokopets, G. A.; Skakodub, V. A.; Strizhak, V. I.; Kravtsov, V. V. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 493-5(Mar 1972). (In Russian).

The recording of gamma quanta formed in inelastic neutron reactions with matter was accomplished with a Ge(Li) detector. Gamma spectra with well separated peaks were produced when the detector was located directly in a 14-MeV neutron beam. A sharp 125-keV peak was obtained from an Fe sample exposed to the 14-MeV neutron beam. (3 figures). (K.S.W.)

High Energy Physics Instrumentation

Refer also to abstracts 10114 and 10425.

9700 (CERN-72-16) EUROPEAN SPIRAL READER SYMPOSIUM, STOCKHOLM, MAY 30-JUNE 1, 1972. Budde, R.; Ekspong, G.; Holmgren, S. O. (eds.) (European Organization for Nuclear Research, Geneva (Switzerland)). 31 Aug 1972. 310p. (CONF-720554).

The 29 papers presented are title listed. (W.H.K.)

For titles of individual papers see: 9701-9729.

9701 (CERN-72-16, pp 3-19) PRESENT PERFORMANCE OF THE WEIZMANN INSTITUTE-TECHNION SPIRAL READER SYSTEM.

9702 (CERN-72-16, pp 21-32) STATUS REPORT OF THE CERN-LSD SYSTEM.

9703 (CERN-72-16, pp 33-55) IONISATION MEASUREMENTS AND THEIR TREATMENT AT CERN-LSD1.

9704 (CERN-72-16, pp 57-61) JUNE 1972 STATUS REPORT OF THE COLLEGE DE FRANCE SPIRAL READER. Dobrzynski, L. (College de France, Paris).

9705 (CERN-72-16, pp 63-5) STATUS REPORT OF THE DANISH-SWEDISH SPIRAL READER: JUNE 1972. Berglund, S.; Holmgren, S.-O.; Lundborg, P. (Univ. of Stockholm).

9706 (CERN-72-16, pp 67-76) TECHNICAL DESCRIPTION OF SRS: SPIRAL READER SAAB. Berglund, S.; Holmgren, S.-O.; Lundborg, P. (Univ. of Stockholm).

9707 (CERN-72-16, pp 77-9) STATUS REPORT ON THE SACLAY SPIRAL-READER. Gandois, B.; Jacquet, M.; Michau, J. C.; Levi, M.; Revel, D. (CEN, Saclay, France).

9708 (CERN-72-16, pp 83-8) FIDUCIALS MEASUREMENTS ON COLLEGE DE FRANCE SPIRAL READER AND PARTIAL RESULTS ON π^-d EVENTS AT 9 GeV/c. Baubillier, M.; Cousinou. M. C.; Rivoal, M.; De Billy, L. (Univ., Paris).

9709 (CERN-72-16, pp 89-98) CALIBRATION, PRECISION, AND STABILITY AT THE COLLEGE DE FRANCE SPIRAL READER. Dobrzynski, L. (College de France, Paris).

9710 (CERN-72-16, pp 99-107) CALIBRATION, PRECISION, AND SYSTEMATIC ERRORS OF CERN-LSD'S.

9711 (CERN-72-16, pp 109-15) SOME CONSIDERATIONS OF SPACE RECONSTRUCTION PRECISION.

9712 (CERN-72-16, pp 117-32) CALIBRATION OF THE DANISH-SWEDISH SPIRAL READER (SAAB-TYPE). Berglund, S.; Holmgren, S.-O.; Lundborg, P. (Univ. of Stockholm).

9713 (CERN-72-16, pp 135-40) ON-LINE PROGRAMMING. Yaari, R.; Gilead, T.; Reuter, B.; Ronat, E. E.; Yaffe, R. (Weizmann Inst. of Science, Rehovot, Israel).

9714 (CERN-72-16, pp 141-53) ON-LINE SOFTWARE FOR THE CERN SPIRAL READERS.

9715 (CERN-72-16, pp 155-8) MAGPIE. Angelstrand, B. (SAAB-SCANIA, Jonkoping, Sweden); Hooper, J. E.

9716 (CERN-72-16, pp 159-60) AUTOMATIC MEASUREMENT OF SIX FIDUCIALS ON HBC 200 FILM. Hooper, John E. (Niels Bohr Inst., Copenhagen).

9717 (CERN-72-16, pp 161-7) SCANDINAVIAN POOH. Dahl-Jensen, E. (Niels Bohr Inst., Copenhagen).

9718 (CERN-72-16, pp 169-70) POOH DEVELOPMENTS AND PARAMETERS ADJUSTMENT FOR SLOW $\bar{p}p$ EXPERIMENTS. Dobrzynski, L. (College de France, Paris).

9719 (CERN-72-16, pp 171-90) OFF-LINE TREATMENT OF MEASUREMENTS PERFORMED ON CERN'S SPIRAL READERS (LSD).

9720 (CERN-72-16, pp 191-4) LINES: A COMPUTER PROGRAMME FOR THE ANALYSIS OF SPIRAL READER MEASUREMENTS OF STRAIGHT LINES. Berglund, S.; Holmgren, S.-O.; Lundborg, P. (Univ. of Stockholm).

9721 (CERN-72-16, pp 197-209) TRACK COMPARISON OF HPD AND SPIRAL READER MEASUREMENTS. Gandois, B.; Jacquet, M.; Levi, M.; Michau, J.-C.; Revel, D. (CEN, Saclay, France).

9722 (CERN-72-16, pp 211-24) MEASUREMENT OF L.S.D. OF $\bar{p}p \rightarrow$ 4 PRONGS AT REST. COMPARISON WITH H.P.D. MEASUREMENTS. Ghesquiere, C. (College de France, Paris).

9723 (CERN-72-16, pp 227-35) ON LINE PREFILTERING AND IMPROVED DATA COLLECTION ON L.S.D. Ghesquiere, C. (College de France, Paris).

9724 (CERN-72-16, pp 237-65) SOME IMPROVEMENTS OF THE LSD OPTICAL SYSTEM.

9725 (CERN-72-16, pp 267-8) FILM'S MEASUREMENTS OF 80 cm CHAMBER. Forlen, M. (College de France, Paris).

9726 (CERN-72-16, pp 269-94) HARDWARE IMPROVEMENTS ON THE TWO CERN LSD SYSTEMS.

9727 (CERN-72-16, pp 295-7) POSSIBLE IMPROVEMENT ON TRACK DETECTION BY VARIATION OF THE SLIT LENGTH.

9728 (CERN-72-16, pp 301-3) FIRST DIGITIZATIONS OF 12' ANL BUBBLE CHAMBER PICTURES ON CERN LSD2.

9729 (CERN-72-16, pp 305-10) SOME DIGITIZATIONS FROM ARGONNE 12' BC ON SRS. Berglund, S.; Holmgren, S.-O.; Lundborg, P. (Univ. of Stockholm).

9730 (CONF-720219-, pp 62-81) ON-LINE DATA ACQUISITION AND ANALYSIS FOR A SPARK CHAMBER EXPERIMENT. Conetti, Sergio (CERN, Geneva, Switzerland). 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

The characteristics of the magnetostrictive spark chamber data acquisition system and the activity of the on-line computer

used by the CERN-Trieste High-Energy Group in their experiments at the CERN PS are described in detail. (auth)

9731 (CONF-720219–, pp 181-7) PARTICLE DETECTOR DEVELOPMENT. Bartl, W. 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

The multiwire proportional chamber that is being developed for use with the split field spectrometer at the CERN ISR is described. (W.H.K.)

9732 (IFVE-SEF/SPK-71-59) HIGH-SPEED FIVE-RAY SCOPE OF IHEP AND ITS APPLICATION IN THE EXPERIMENTS ON INVESTIGATIONS OF RARE PROCESS. Zaitsev, A. M.; Utochkin, B. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The design and operational principles of a high-speed five-ray scope, that was exploited in a number of experiments at the IHEP 70 GeV accelerator including a search for particles with a fractional charge (quarks and dequarks), for observing antihelium-3, etc., are described. The rise-time for each of five "y" channels is less than 4.5 nsec and the deflection sensitivity is 30 mV/cm. The driven sweep generator common for all the channels is in the speed range from 5 to 500 nsec/mm. Block diagrams and a general view are given. (auth)

9733 (IFVE-SVM-71-97) CALCULATION OF THE NON-HOMOGENEITY OF A MAGNETIC FIELD IN THE RECONSTRUCTION OF THE TRAJECTORY OF A PARTICLE IN A BUBBLE CHAMBER BY THE METHOD OF BROKEN CURVES. Zhigunov, V. P.; Nikitin, S. G.; Perelygin, V. F.; Sokolov, S. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

The method of broken curves, which reconstructs the particle trajectory taking into account multiple scattering and energy losses, is generalized for the case of inhomogeneous magnetic fields in the bubble chamber. (auth)

9734 (JINR-P13-6682) CONDENSED INERT GASES AS WORKING MEDIA FOR SPECTROMETRIC DEVICES IN HIGH ENERGY PHYSICS. Ryabtsov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of experimental data, it is shown that the condensed gases Ar and Xe can successfully be used as the working media of ionization spectrometric devices in high energy physics. It was found that the condensed gases Ar and Xe have a number of remarkable characteristics including 1) drift velocity is large (it is possible to obtain good time characteristics); 2) drift length of electrons and ions can be very large; 3) free charges are practically absent; 4) Ar and Xe have small values of ω-energy consumed to create the ion pair; 5) xenon has a high atomic number Z = 54 which makes it possible to make devices for precision measurements of γ-quanta energy and high energy electrons; 6) it is possible to obtain homogeneous volumes of working medium of any desired form and of any sizes; and 7) condensed Ar and Xe have a small value of dielectric constant ($\epsilon < 2$) that permits making devices with large working areas. (auth)

9735 (JINR-P13-6703) STREAMER CHAMBER FOR "RESONANCE" EQUIPMENT AND ATTENDING SYSTEMS. Vishnevskii, V. F.; Askarkhodzhaev, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

A short description of the "Resonance" equipment designed in the Laboratory of High Energies (JINR) is given. The main peculiarities of the streamer chamber, which forms the basis of the equipment, are described as well as the photo-system and gas-scrubbing system. (auth)

9736 (UH-511-92-71) DELTA-RAYS AND THE PROPORTIONAL QUANTAMETER. Yount, D. [Hawaii Univ., Honolulu]. Feb 1971. Contract AT(04-3)-511. 19p. Dep. NTIS.

The limiting effects of delta-ray statistics on the resolution of proportional quantameters are studied. Delta-ray statistics is divided into two regimes: Landau statistics when the number of delta rays near E_{max} is small and Gaussian statistics when the number of delta rays near E_{max} is large. Experimental results and calculations using both Gaussian and Landau statistics are presented and discussed. (W.H.K.)

9737 APPARATUS AND METHOD OF INVESTIGATING MULTIPLE PRODUCTION AT ENERGIES OF HUNDREDS OF GeV. Guseva, V. V.; Dobrotin, N. A.; Denisov, E. V.; (and others). Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 1-24(1971).

Large experimental apparatus is described, which is used in a program of research on inelastic interactions of cosmic-ray particles with energies in the 100 to 1000 GeV range. Included are two ionization calorimeters. The first, used to measure the energy of individual cosmic-ray particles from the absorption of electron-nuclear cascades generated in a dense medium, consists of 20 horizontal rows of ionization chambers separated by absorbers. The ionization chambers are rectangular with cross sections of 5.5 by 16.4 cm, and are fabricated from brass waveguides with a 2.5 mm wall thickness. The chambers are filled with Ar and have an α source located in the chamber which checks the purity of the Ar. The second calorimeter consists of eight layers of absorbers separated by 120 ionization chambers, which are fabricated from Cu and Fe tubes of 38 and 64 mm respectively. These chambers are also filled with Ar. A cloud chamber, which is described, is situated in a magnetic field of 6000 G. The sensitive volume measures 1050 by 700 by 350 mm. The chamber produces information on secondary particles with pulses recorded on a 45 channel analyzer. (F.S.)

9738 METHOD OF TREATMENT OF EXPERIMENTAL DATA OBTAINED WITH CLOUD CHAMBER. Guseva, V. V.; Zelevinskaya, N. G.; Kotel'nikov, K. A.; (and others). Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 25-34 (1971).

A method is described for selecting events and conducting measurements and calculations for the analysis of photographs of cosmic-ray showers with energies of hundreds of GeV. Inelastic interactions of cosmic-ray particles with LiH are visually examined with a semiautomatic stereocomparator. The stereocomparator was made by attaching two microscope heads to a UIM-21 microscope. The stereocomparator is fitted with a system for automatic data recording. (F.S.)

9739 EXPERIMENTAL DATA ON INELASTIC STRONG INTERACTION AT ENERGIES OF 100 TO 3000 GeV AND THEIR INTERPRETATION. Slavatinskii, S. A. Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 35-90(1971).

Results are given for the analysis of experimental data obtained in ionization calorimeters and cloud chambers. The cloud chambers recorded 102 showers. Energy of the primary particle was accurately recorded in 86 of the showers. For the other 14, the minimum value of the energy was determined. Sixty-nine showers were generated in a LiH target, 26 in a Be target. Due to the position of the Be target inside the cloud chamber, information about the momentum of the secondary particles is unreliable. (F.S.)

9740 APPARATUS FOR INVESTIGATION OF EXTENSIVE AIR SHOWERS AND NUCLEAR INTERACTIONS OF COSMIC-RAY PARTICLES WITH ENERGY 10^{12} TO 10^{16} eV. Amineva, T. P.; Aseikin, V. S.; Vavilov, Yu. N.; (and others). Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 140-57(1971).

An apparatus designed for comprehensive investigation of the central region of extensive air shower, nuclear-active particles, and high-energy muons is described. The apparatus consists of a large ionization calorimeter, neutral supermonitor, central array of scintillation counters, four scintillation counters at a distance of 20 meters from the center of the apparatus, an assembly of peripheral scintillation counters, a hodoscope arrangement for determination of electron flux, and Cherenkov detectors. (F.S.)

9741 MEASUREMENT OF ENERGY OF ELECTRON-PHOTON CASCADES BY PHOTOMETRY OF SPOTS ON X-RAY FILMS. Baradzei, L. T.; Kanevskaya, E. A.; Smorodin, Yu. A. Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 178-88(1971).

A method is described for measuring the energy of electron-photon cascades by photometry of the black spots on x-ray films. A comparison of energy measurement in nuclear emulsions and x-ray films shows that in the energy range 10^{12} to 10^{13} eV the two methods are equally accurate, work with x-ray films is much easier, and x-ray films exhibit less image regression. X-ray films can not be used for energy measurements below 10^{12} eV. The threshold for nuclear emulsions is below 10^{11} eV. (F.S.)

9742 TRANSITION EFFECTS IN THE IONIZATION CALORIMETER. Fetisov, I. N. Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 189-201(1971).

To provide greater accuracy in cosmic-ray measurements, experimental transition effects in an ionization calorimeter were investigated on an accelerator to obtain sufficiently accurate results. The integral transition effect was found to be practically independent of the primary energy of the electrons for energies >100 MeV. The integral transition effect for an electron-nuclear cascade differs from the integral transition effect for an electromagnetic cascade by not more than 5%. (F.S.)

9743 SERVOMECHANISM FOR CONTROL OF A SCANNING DEVICE. Frisch, O. R.; Brandon, G. S. British Patent 1,286,809. 23 Aug 1972. Filed 12 Nov 1968.

Apparatus is described for steering a light beam, and which is particularly suitable for use in a track-following machine measuring bubble-chamber photographs. The apparatus comprises a pair of steering mirrors pivoted about perpendicular axes and electromagnetically movable about these axes to the required positions. Each mirror has an interferometric system for detecting its movement and a servomechanism to generate control currents for moving the mirror to a set position. The servomechanism comprises a digital store into which a control input, representing the set position, can be entered, and means for comparing the set position with a digital indication of the actual position derived from the interferometric system, with means for generating control currents to accelerate the mirror towards the set position until the comparison means indicates that the actual position is midway between the initial position and the set position, and then decelerate the mirror at the same rate. Means are provided, operative as the mirror approaches the set position, to generate control currents dependent on the sign of the divergence from the set position, and on whether this divergence is increasing or decreasing to apply a greater force to the mirror when it is moving away from the set position than when moving towards a set position. The interferometric system may be of Michelson type. V-mirrors having a 90° included angle may be mounted on each steering mirror to return the interfering beams always in the same direction. The means for generating control currents may comprise a pair of transistors that can be selectively rendered conductive, depending on the required direction of motion, by control pulses. (UK)

9744 STATUS OF IRVINE COSMIC RAY MUON FACILITY. Moe, M. K.; Lathrop, J. F.; Reines, F. (Univ. of California, Irvine). pp 2453-6 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Four 1 × 5 m, double gap magnetostrictive spark chambers and an 83 ton magnet are now in place and beginning to gather data on the horizontal cosmic-ray muon spectrum. The spectrometer has a maximum detectable momentum of 5 TeV/c with an aperture of 0.1 m^2 sr. A target consisting of lead, proportional counters, and spark chambers will be added to study the interactions of high-energy muons. The system is expandable to a m.d.m. of 15 TeV/c and an aperture of 0.3 m^2 sr., with a penetrated target of up to 500 tons. (auth)

9745 RADIATION OF CHARGED PARTICLES IN NONHOMOGENEOUS MEDIA AND THE APPLICATION OF THIS RADIATION TO THE DETECTION OF SUPERHIGH ENERGY PARTICLES. Franghian, A. A.; Harutjunian, F. R.; Nazarian, A. A. (Inst. of Physics-Research, Yerevan, USSR). pp 2469-76 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The results of the experimental investigation on radiation that originates on passing of a high energy particle through periodical laminar media (resonance radiation) in the x-ray region of spectra are generalized. The application of this radiation to the detection of single particles is considered. The measured absolute value of radiation intensity, its spectral distribution, energetic dependence and other characteristics of electrons with an energy of 0.25 to 3.7 keV show that the radiation in a laminar medium is defined mainly by interference effects. The experimental data are in good agreement with the resonance radiation theory, which is a more general theory. In special cases, when interference conditions are absent, this theory leads to the transition radiation of bremsstrahlung formulas. The latter can be considered as a "thermal" background for resonance radiation. The influence of multiple scattering in laminar media on the radiation is analyzed. This influence for comparatively low energy electrons (0.25 to 0.6 GeV) leads to an additional interference radiation in laminar medium. The intensity of this additional radiation may be even higher than the total intensity of transition radiation and bremsstrahlung taken together. The detection system, based on using the radiation of charged particle in laminar media (RRD–resonance radiation detector) is similar to a Čerenkov counter in distinguishing the direction of the movement, as well as in its threshold characteristics; however, it differs from the Čerenkov counter by the capability of working in the range of great values of E/mc^2, where the usual Čerenkov counter can not distinguish one energy from another. Various ways of particle detection by means of this method are analyzed and the results of a few experiments are discussed. Characteristics of various electron detectors in various energy ranges are presented. The work of the detector in a concrete experiment of separating the electrons from π^--meson beam with a moment of 2.8 GeV/c is discussed too. The constructed detector (RRD) will be especially effective in the range of $E/mc^2 \gtrsim 10^4$. The detection efficiency of nearly 100% is not restricted by any difficulties of principle. (auth)

9746 CALCULATION OF TRANSITION EFFECTS IN IONIZATION CALORIMETER. Kolchuzhkin, A. M.; Ryzhov, V. V.; Uchaikin, V. V.; Shoshin, E. B. pp 2477-87 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

It is shown that the integral value of the transition effect in an ionization calorimeter does not depend on the angular and energy distribution of incident particles. The results of calculations are given for Pb and Fe calorimeters with ionization chambers and scintillators. (auth)

9747 IONIZATION OF RELATIVISTIC PARTICLES IN Ar–He MIXTURE AND COMPARISON OF EXPERIMENTAL DATA WITH THE THEORY. Kim, V. M.; Kotelnikov, C. A.; Merson, G. I.; Puchkov, U. S. (Lebedev Inst. of Physics, Moscow). pp 2488-97 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The ionization produced by cosmic ray muons and electrons in the cloud chamber filled with argon–helium mixture at 0.3 atm was measured by counting drop method in the region of $\beta\gamma = 3$ to 1000. The aim of the experiment is to study the possibility of pion and proton discrimination above 100 GeV according to the relativistic rise. The comparison of the results both with Sternheimer theory predictions and calculations based on the modified theory taking into account conditions of track observation in gaseous detectors is made. (auth)

9748 METHOD OF DETERMINATION OF γ-RAY POLARIZATION ABOVE $E\gamma = 1$ MeV. Galper, A. M.; Kelner, S. P.; Kirillov Ugryumov, V. G.; Kotov, Y. D.; Logunov, V. M. (Inst. of Engineering Physics, Moscow). pp 2498-2511 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A method used to measure linear polarization of gamma rays in the energy interval from 1 to 100 MeV is given. This method is based on measurements of the position of the plane of dispersion of an electron-positron pair. The value of the asymmetry parameter in the same energy interval, with regard for multiple scattering, was obtained. The optimum converter thickness for measurements of the polarization, in the above energy range, was calculated. The number of events necessary to measure a certain degree of the polarization was found. In addition, the question of precision of reconstruction of the γ-ray pulse direction through the bisector of the angle along this pair was studied. The possibility of obtaining the energy spectrum of photons by analyzing the events in the track detector was discussed. (auth)

9749 100-CHANNEL SCINTILLATION TELESCOPE. Aleksejev, E. N.; Bakatanov, V. N.; Dadykin, W. L.; (and others) (Lebedev Inst. of Physics, Moscow). pp 2516-20 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A 100-channel liquid scintillation telescope is described. It allows one to carry out an uninterrupted registration of cosmic rays intensity. The telescope consists of 4 layers, situated in 1.3 m distance one above another. The area of each layer is 12.25 m^2. It permits registration of the counting rate of 2, 3, and 4 layers coincidence. The statistical error for 4 layers coincidence is 0.07 percent for one hour. It permits registration of the intensity of the inclined component of cosmic rays with the maximum direction of 53° to the zenith in the East, West, North and South directions with the statistical accuracy 0.13 percent for one hour. (auth)

9750 CONSISTENT METHOD OF PHOTOMETRICAL DETERMINATION OF ELECTRON–PHOTON CASCADE ENERGY IN EMULSION CHAMBERS WITH X-RAY FILMS. Baradzey, L. T.; Kanevskaya, E. A.; Smorodin, Yu. A. (Lebedev Inst. of Physics, Moscow). pp 2521-31 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Some previously published methods of the electron-photon cascade (EPC) energy determination in emulsion chambers by opacity spots in X-ray films gave rise to some internal inconsistency. Sometimes doubts appear in the application of the elementary theory of emulsion opacity to the process of spot formation by the EPC. The reasons of such disagreements are in the effects owing to the diffusion of light in photometric measurements of spot and the dependence of photometric densities in double layered X-films upon the inclined fall of EPC. The both effects may successively be taken into account if one uses spot densities in one layer of double-layered X-ray film as in this case it is possible to perform the calculation with conditions equal to experimental ones. Such a method of EPC energy determination by photometric densities in several circles with the radii 50 to 150 μm was developed. The new method removes the internal inconsistencies and is in good agreement with the method of counting electron tracks in nuclear emulsions. On the basis of this new method and experimental data one can take into account the average above-mentioned effects while measuring photometric densities in double layered X-films. The root-mean square energy spread amounted to 15%. (auth)

9751 AUTOMATIC SCANNER FOR NUCLEAR EMULSION PLATES. Fischer, B. E. (Univ., Marburg, Ger.). Nucl. Instrum. Methods; 105: No. 3, 413-26(1972).

An automatic scanner has been built to count tracks in nuclear emulsions exposed in magnetic spectrographs. It scans up to 200 times faster than human scanners. Counting accuracy for high contrast plates is comparable to that of human scanners except in extremely low or high density regions. The device described differs from other automatic scanners in that it has a fiber optic illumination system, a specially designed parallel processing computer for track recognition and a relatively low price. Special attention is given to the problem of optical preprocessing of track information to facilitate the recognition of tracks. (auth)

9752 CHERENKOV COUNTERS FOR PARTICLE IDENTIFICATION AT HIGH ENERGIES. Benot, M.; Litt, J.; Meunier, R. (CERN, Geneva). Nucl. Instrum. Methods; 105: No. 3, 431-44 (1972).

The general design features of the threshold, differential, and DISC types of gas Cherenkov counters are discussed in the context of their application as particle detectors at high energies. (auth)

9753 SPARK CHAMBER OPERATION IN A MAGNETIC FIELD WITH LARGE DELAYS. Bostandzhyan, N. Kh.; Marikyan, G. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 8, 1803-5(Aug 1972). (In Russian).

Two spark chambers were positioned in the gap of an electromagnet for studying the character and measurement of displaced tracks from particle trajectories under the influence of electric and magnetic fields. The displacement or shift of tracks was investigated as functions of the angle between the route of the particles and the electric field, and of the intensity of the magnetic field (which was perpendicular to the electric). (K.S.W.)

9754 MEDIUM ENERGY PION BEAM MONITORING SYSTEM. Barbini, R.; Faini, D.; Guaraldo, C.; (and others) (CNEN, Frasacti, Italy). Nucl. Instrum. Methods; 105: No. 3, 515-18 (1972).

A monitoring system for the LNF-LEALE positive and negative medium energy pion beams is described. The system is based upon the integral measurement of the beam charge, in analogy with Faraday-cup methods used for electron beams. Results of experimental tests are reported together with a discussion of correction methods obtained by Monte-Carlo techniques. (auth)

9755 LARGE-APERTURE CHERENKOV HODOSCOPE FOR IDENTIFICATION OF MULTI-PARTICLE STATES. Williams, H. H.; Kilert, A.; Leith, D. W. G. S. (Stanford Univ., CA). Nucl. Instrum. Methods; 105: No. 3, 483-91(1972).

A large-aperture Cherenkov chamber has been designed and constructed at SLAC for use in identifying particles in 1, 2 and 3 body-final states. It is basically a threshold type counter, but the optics is designed such that each of the eight 62.5 × 62.5 cm^2 spherical mirrors reflects the Cherenkov light into a corresponding light horn and phototube; the counter may therefore be used as a hodoscope of eight optically independent Cherenkov cells. In addition, the pulse-height information from each phototube is recorded so that particle identification may be made in some cases on the basis of how much light was emitted. The performance of the counter for single and multi-particle identification is discussed. (auth)

Radiometric Instruments

Refer also to abstracts 9265 and 9805.

9756 (SC-RR-720720) CHARACTERIZATION OF NTS FILM SAMPLES. Langley, R. A. (Sandia Labs., Albuquerque, N. Mex.). Nov 1972. 24p. Dep. NTIS.

Fifty sputter-evaporated films were characterized as to thickness and film–substrate diffusion using the backscattering technique. The films, consisting of Au, W, TaC, and ThO_2, were provided by Division 5323 for use in a material test study. The thicknesses were deduced from the backscattering data by three independent methods: the first method used the measured stopping cross sections of the film material; the second method used the measured stopping cross sections of the substrate; and the third method gave a relative measure based on the total number of film-backscattered beam particles. The results of the different methods are compared and found to agree quite well. Values for the thicknesses are given along with their probable errors. No significant interdiffusion between film and substrate was found in any case. (auth)

9757 TALL USEFUL RANDOM DRIVER (28 Jul 1972) (Engineering Materials). ((Los Alamos Scientific Lab., N. Mex.). (CAPE-2274).

13 drawings.

The Tall Useful Random Driver, which is described, is an assay instrument for rapid nondestructive measurements of the fissile content of product, feed, scrap and waste nuclear materials. It will accommodate samples up to 8 in. dia. and 24 in. high. A random neutron source located inside the counter interrogates the moving sample producing fissions in the fissile material within the sample. The induced fission neutrons are detected with a fast neutron detector. A coincidence logic system is used to distinguish the random source neutrons from the time-correlated fission neutrons. The induced fission rate is proportional to the fissile content of the sample. (auth)

9758 INVESTIGATION OF THE TIME SPECTRA OF THE NANOSECOND RANGE IN HOMOGENEOUS MEDIA. Krasil'nikov, B. N.; Rekhin, E. I.; Pankratov, V.M. Yadern. Priborostr.; No. 14, 57-62(1971). (In Russian).

The development of a method for the evaluation of mineral reserves, based on the registration of the time distribution of scattered γ radiation from point radiation sources, is examined. The time spectra presented showed the dependence of the spectra on the density of the medium which gives the possibility of evaluating mineral reserves. (tr-auth)

9759 NEUTRON RADIATION ANALYTICAL METHODS AND INSTRUMENTS. Egiazarov, B. G. Yadern. Priborostr.; No. 14, 63-88(1971). (In Russian).

Neutron radiation methods and instruments based on the registration and investigation of the secondary γ radiation from the inelastic scattering of neutrons, radiation capture, induced activity, and partially delayed neutron radiation, are examined. Experimental circuits and measurement regimes with neutron generators and isotopic neutron sources are discussed. (59 references) (tr-auth)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

9760 (EGG-1183-2280) DEVELOPMENT OF LOW-Z PEAK PRESSURE AND HIGH TEMPERATURE MANGANIN GAUGES. Charest, J. A.; Schlueter, W. A. (EG and G, Inc., Goleta, Calif.). Oct 1971. Contract AT(29-1)-1183. 34p. Dep. NTIS.

An in-material 50-Ω encapsulated beryllium shock peak pressure gauge has been developed for use in high radiation environment, and calibrated in the pressure range 35 to 150 kbars. The gauge consists of a photoetched 0.0006-in.-thick piezoresistive grid and lead assembly encapsulated between two 0.001-in.-thick sheets of Kapton using epoxy resin as the gauge filler. The working principle of the beryllium gauge is based on the strong dependence of its electrical resistance on temperature, which in turn is a unique function of shock pressure. Also, an in-material 50-Ω encapsulated stress wave Manganin gauge has been developed for use at 500°F and calibrated in the pressure range 15 to 30 kbars. The Manganin gauge consists of a photoetched 0.0008-in.-thick piezoresistive grid and lead assembly encapsulated between two 0.001-in.-thick sheets of Kapton using a high temperature epoxy as the gauge filler. The high temperature Manganin gauge

showed a slight increase of its piezoresistivity (~5%) over a room temperature gauge. (auth)

9761 (LA-DC-72-1344) REVIEW AND STATUS OF RADIATION EFFECTS STUDIES ON STRAIN GAGES. Tallman, C. R. (Los Alamos Scientific Lab., N. Mex.). 1972. 46p. (CONF-721012-2). Dep. NTIS.

From Fall meeting of the Society of Experimental Stress Analysis; Seattle, WA (17 Oct 1972).

A review of the theoretical and experimental studies of basic damage mechanisms expected in the components of strain gages is presented; and system experiments conducted on various strain gage systems of different gage alloys, bonding methods, and reactor environments are described. (21 references). (W.H.K.)

9762 PHOTOMULTIPLIER TUBE PULSES INDUCED BY HIGH ENERGY ELECTRONS. Fukui, S. (Nagoya Univ., Japan); Watanabe, K.; Yamamoto, A.; Kasuya, M.; Fujii, T. Nucl. Instrum. Methods; 105: No. 2, 391-3(1972).

Noise pulses from photomultiplier tubes, directly subjected to 245-MeV electrons, were investigated. The observed pulse, corresponding to an average of 9 equivalent photocathode electrons, was mostly attributed to Cherenkov radiation in the front glass. (2 figures) (auth)

9763 ESTIMATION OF ERRORS CAUSED BY RADIATION AND TEMPERATURE ON COAXIAL SIGNAL CABLES. Stringer, J. L.; Bourassa, R. R.; Dau, G. J. (Battelle Northwest Labs., Richland, WA). Nucl. Technol.; 17: No. 1, 71-8(Jan 1973).

To evaluate the combined effects of radiation induced conductivity and radiation induced currents on readout errors as a function of radiation and temperature, an equivalent dc circuit was developed for a coaxial cable in a reactor core. Experimentally obtained data are used in this circuit to estimate readout errors as a function of source impedance and source output voltage for radiation and temperature fields of 5×10^9 R/h and 1200°F. It was found that in this radiation and temperature environment, significant errors will not result from a voltage source with output greater than 10 mV for a cable-sensor combination under the following conditions: 1) source impedance <100 Ω, 2) total radiation induced current equal to −1 μA, 3) 3 ft of cable in a flux zone of 5×10^9 R/h and 1200°F; 25 ft of cable in 10^6 R/h and 1200°F, and 4) stainless steel sheath and center conductor cable, 0.250 in. o. d., 0.025 in. diameter conductor, 0.019 in. sheath thickness in MgO insulation. It was also found that 1) radiation induced conductivity of powdered MgO changes linearly with dose rate to at least 9×10^{10} R/h, and 2) the magnitude and polarity of radiation induced currents are independent of temperature. The specific results were obtained with a general model which can be used to estimate errors in other radiation and temperature environments. (auth)

9764 NEUTRON DAMAGE ANNEALING IN SILICON n-CHANNEL JUNCTION FIELD EFFECT TRANSISTORS. Gregory, B. L. (Sandia Labs., Albuquerque, NM). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 476-9(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

Annealing of neutron damage was studied in n-channel, epitaxial silicon JFET's. This study includes measurements of the parameters g_{mss}, I_{DSS}, and V_{PO} in devices with various phosphorus concentrations in the channel region. The recovery in device parameters during isochronal annealing exhibits a significant dependence on both the exposure fluence and the phosphorus concentration. The fluence dependence is due to the nonlinear relationship between device parameters and defect concentration. The dependence on the phosphorus concentration is thought to be caused by E-center formation and breakup during neutron damage reordering. The recovery observed in the JFET's during annealing occurs at temperatures which are commonly reached during normal operation of power devices. Hence, significant self-healing of damage may occur during operation of such devices. (4 figures, 1 table) (auth)

9765 EFFECTS OF 10 TO 150 keV PROTON BOMBARDMENT ON SILICON SOLAR CELLS. Rostron, R. W. (COMSAT Labs., Clarksburg, MD). Energy Convers.; 12: No. 4, 125-9 (Dec 1972).

The damaging effects of very low energy protons (10 to 150 keV) on silicon solar cells have been investigated. The changes in short-circuit current, open-circuit voltage, maximum power, fill factor, and "n" parameter were observed as the solar cell sustained damage in the surface, junction, and base regions. Both partially shielded and bare solar cells were studied. The experimental results are compared with known theory of the solar cell. (auth)

Miscellaneous Instruments

Refer also to abstracts 10095, 10864, 11192, and 11202.

9766 (JINR-E13-6673) USE OF p-i-n DIODES IN NUCLEAR ELECTRONIC CIRCUITS. Horvath, P.; Mukhin, S. V.; Rikhvitskii, S. V.; Streit, V.; Zvada, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 17p. Dep. NTIS (U. S. Sales Only).

Attenuators and bipolar pulse shapes that use p-i-n diodes are described and specifications are presented. Small-signal characteristics of the diode-twins were measured in the 30 to 900 MHz frequency range. The diode characteristics and some advantages of the p-i-n diode used in pulse circuits for nanosecond and subnanosecond range are discussed. (auth)

9767 (LA-4948) MULTIMODE INTERFACE BETWEEN A PDP-9 COMPUTER AND A GEOSCIENCE ADC/PROCESSOR. Morris, R. A.; Dalton, L. J. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 33p. Dep. NTIS.

The hardware design of an interface used for general-purpose data acquisition and analysis and some examples of the software necessary to operate it are described. The interface permits the computer to accept data from nuclear counting experiments with an average deadtime of 2 to 3 μsec (not including ADC deadtime), to digitize and store analog signals from nondestructive tests, and to use an external memory as a type of random access mass storage. Wiring and logic diagrams are included, as well as the software listings, of typical operating subroutines. Two computer-initiated pulses are also available at the front panel of the interface and may be used by the experimenter to control external devices. (auth)

9768 (ORNL-4822) INSTRUMENTATION AND CONTROLS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 1, 1972. Sadowski, G. S. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 131p. Dep. NTIS.

DATA ACQUISITION SYSTEMS—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
ELECTRONIC EQUIPMENT—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
ENVIRONMENT—research at ORNL, Aug. 31, 1971–Sept. 1, 1972
INSTRUMENTS—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
OAK RIDGE ELECTRON LINEAR ACCELERATOR—developments at, Aug. 31, 1971–Sept. 1, 1972
PROCESS EQUIPMENT—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
RADIATION DETECTORS—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
RADIATION MONITORING—research at ORNL, Aug. 31, 1971–Sept. 1, 1972
REACTOR CONTROL SYSTEMS—development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
REACTOR EXPERIMENTAL FACILITIES—instrumentation for, development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
REACTORS—instrumentation for, development and research at ORNL, Aug. 31, 1971–Sept. 1, 1972
THERMOMETRY—research at ORNL, Aug. 31, 1971–Sept. 1, 1972 (W.H.K.)

9769 (ORNL-TM-4006) INSTABILITY LIMIT ON THROUGHPUT FOR CALUTRONS. Alexeff, Igor (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 5p. Dep. NTIS.

The instability limit on calutron throughput caused by the relative streaming on one ion species through the other is calculated. (W.H.K.)

9770 (UCRL-73928) DEVELOPMENT OF A SMALL DATA ACQUISITION AND CONTROL COMPUTER SYSTEM. Siemens, P. D.; Bourret, S. C. (California Univ., Livermore. Lawrence Livermore Lab.). 12 Sep 1972. 6p. (CONF-721047-1). Dep. NTIS.

From 3rd symposium on stored program controllers; Los Alamos, NM (16 Oct 1972).

A computer-based data acquisition and control system for a gas radiochromatography apparatus is briefly described. (W.H.K.)

9771 COMPACT TWO-STEP DILUTION REFRIGERATOR FOR LOW TEMPERATURE NUCLEAR POLARIZATION. Nagamine, K. (Tokyo Univ.); Nishida, N.; Ishimoto, H. Nucl. Instrum. Methods; 105: No. 2, 265-8(1972).

There are described the construction and performance of a compact dilution refrigerator which is intended to be used for low-temperature nuclear-polarization experiments including

"in-beam" nuclear orientation works and a polarized nuclear target. The refrigerator has only two "sintered-copper" heat exchangers. Some simplifications were made on the fabrication of sintered-copper sponges and also on the flow impedance matching technique. The dilution cryostat and pumping system are compact and can easily be transported to other places. Radioactive nuclear samples were kept below 50 mK continuously and down to 30 mK transiently. It was successfully applied to orient Bi isotopes in a ferromagnetic BiMn compound which can also be used as a polarized ^{209}Bi target. (3 figures) (auth)

9772 DIGITALLY STABILIZED TIMING SYSTEM. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 105: No. 2, 349-56(1972).

Investigations on a digitally stabilized timing system are presented. Most of the spectrum stabilizer circuitry was built by means of integrated circuits. Some of the problems pertaining to the injection of the timing reference signals are considered. The spectrum stabilizer presented can be used also as part of a high-resolution γ-ray spectrometer. (6 figures) (auth)

9773 SIMPLE 1024 CHANNEL PULSE HEIGHT ANALYSER FOR NUCLEAR PULSE SPECTROSCOPY. Ragupathy, S. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods; 105: No. 2, 357-69(1972).

A 1024-channel pulse height analyzer adaptable for nuclear pulse spectroscopy is described in this paper. It consists of an analog-to-digital converter, a digital data processor, and analog and digital output electronics. Its performance and applications are also briefly reported. The circuits described are simple and reliable with adequate speed required for most types of work in nuclear pulse spectroscopy. (8 figures) (auth)

9774 THREE-AXIS MAGNETOMETER WITH DIGITAL READOUT, SUITABLE FOR BALLOON BORNE APPARATUS. Sanderson, T. R. (European Space Research and Tech. Center, Noordwijk, Netherlands). Nucl. Instrum. Methods; 105: No. 2, 371-6(1972).

A magnetometer suitable for determination of the attitude of a balloon payload is described. The magnetometer uses three fluxgate elements and includes an analog-to-digital converter. The instrument is capable of measuring to better than 1° over an extended temperature range, and meets the requirements of low cost and low power consumption. (6 figures) (auth)

9775 RESISTANCE MEASURING APPARATUS (Engineering Materials). (Ames Lab., Iowa). (CAPE-2289).

2 drawings.

A resistance measuring system is described, which has been used to establish phase transitions and phase boundaries in the thorium-carbon system at temperatures up to 2500°C. It can be used to detect phase transformations and solid-state reaction kinetics at lower temperatures, to study resistance of liquid metals as a function of temperature, and in any situation in which a measure of the change in resistance with time or temperature yields useful information. (F.S.)

9776 INTERACTION BETWEEN CORRELATED AND UNCORRELATED TIME-INTERVAL DISTRIBUTIONS IN START-STOP TIME-TO-AMPLITUDE CONVERTERS. Lowe, L. M.; Boulter, J. F.; Prestwich, W. V. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 105: No. 3, 461-6(1972).

An interaction between correlated and uncorrelated time-interval distributions in start-stop time-to-amplitude converters was observed. Investigation of the effect under controlled conditions showed the interaction to be dependent on the efficiency of the stop event detector. A rapidly convergent iteration method was developed to remove the uncorrelated events from the time-interval distribution. The method was tested on both experimentally and theoretically generated data. (auth)

9777 DESIGN OF A CELESTIAL THOMSON-SCATTERING X-RAY POLARIMETER. Landecker, P. B. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 463-75(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A general discussion of the scientific importance and status of stellar x-ray polarimetry is presented. A stellar x-ray polarimetry is presented. A stellar x-ray polarimeter designed to fit into the bottom half of the NASA Orbiting Solar Observatory-I (OSO-I) wheel compartment or other similar spacecraft is described. In this design, the linear polarization is obtained as a function of energy. The sensitivity of the polarimeter in the 4 to 24 keV energy range was optimized with the aid of a Monte Carlo simulation computer program, and is given for several important celestial x-ray sources. Estimates of sensitivity thresholds for a much larger polarimeter, suitable for flight in the NASA High-Energy Astronomy Observatory (HEAO), are also given. The minimum detectable polarization for several x-ray sources is given. For example, the minimum detectable polarization at the 99% confidence level for the Crab nebula in a 24 h observation time is 1.4% for an OSO polarimeter in a compartment (50 × 30 × 30) cm and 0.27% for a HEAO polarimeter in a compartment (100 × 100 × 30) cm. These satellite experiments are feasible and will yield significant polarization results, which will have an important bearing on the understanding of x-ray source mechanisms. (9 figures, 5 tables, 60 references) (auth)

9778 ION CYCLOTRON RESONANCE. I. PRINCIPLE AND APPARATUS. Degelaen, J.; Burton, T. (Univ., Louvain, Belg.). Ind. Chim. Belge; 37: No. 5, 429-34(1972). (In French).

Ion cyclotron resonance is a useful method for the study of systems containing ions and neutral molecules. The principle and the apparatus of ion cyclotron resonance are explained. (auth)

9779 PRESENT STATUS AND FUTURE PROSPECTS FOR THE DEVELOPMENT OF DIGITAL MEASURING DEVICES FOR NUCLEAR PHYSICS AND ATOMIC INDUSTRY. Kurochkin, S. S. Yadern. Priborostr.; No. 14, 3-13(1971). (In Russian).

The basic trends in the development of specialized digital devices for nuclear physics (multichannel analysis, counting systems, correlators) as well as measuring systems designed on the basis of universal digital computers are examined. The feasibility of constructing systems based on a series of unified associated digital computers, similar to the IBM-360 series, and standard data channels of the SAMAS type is emphasized. The construction plan of these systems is examined. (tr-auth)

9780 METHOD FOR THE DETERMINATION OF THE INTEGRAL CHARACTERISTICS OF AMPLITUDE ANALYZERS. Kurochkin, S. S.; Prisada, V. M. Yadern. Priborostr.; No. 14, 14-24(1971). (In Russian).

Methods for the determination of the integral characteristics of analyzers are examined. An angular method is proposed for analytical determination of the parameters of the integral characteristics. Formulas are given for the calculation of the integral characteristic parameters when experimental points are measured with significant errors. (tr-auth)

9781 METHOD OF INCREASING THE PRECISION OF READING OF THE NUMBER OF CHANNELS OF AMPLITUDE ANALYZERS. Kurochkin, S. S.; Prisada, V. M. Yadern. Priborostr.; No. 14, 25-9(1971). (In Russian).

The introduction of the modulation of the signal of generators with stable and precise amplitude is proposed for increasing the precision of the reading of the number of channels during measurements of the conversion characteristics of multichannel amplitude analyzers. It is shown that for modulation it is advisable to use sinusoidal voltage. Formulas are given for the determination of the real value of the number of channels when fluctuation of the signal, induced by the modulation, is 0.7 channels. (tr-auth)

9782 SPECIALIZED MEMORY DEVICES. Kozyr, A. I.; Kruglov, Yu. A.; Kuznetsov, K. F.; Maksimov, Yu. V.; Rogushin, I. I. Yadern. Priborostr.; No. 14, 30-42(1971). (In Russian).

Questions on the construction of few-channel high speed memory devices for use in nuclear physics are examined. A description is given of the structural and basic designs of developed memory devices with ferrite cores constructed on the 2D system with 32 addresses and 18 digital orders. Readout times of 0.5 and 0.8 μsec respectively were obtained. The efficiency of the memory devices in the temperature range from 0 to 50°C was guaranteed by thermofunctional control of the current of the matrix drive. (tr-auth)

9783 PRECISE AND STABLE AMPLITUDE GENERATOR WITH TRANSISTOR SWITCH. Rasputnyi, V. N.; Mironov, I. I. Yadern. Priborostr.; No. 14, 43-56(1971). (In Russian).

A precise and stable amplitude generator (GTA) with a compensated transistor switch with series coupling of the two transistors is examined. Those factors limiting the characteristics of the GTA, such as fluctuation of the temperature, load and control current, time drift, buildup time, and pulse decay, are taken into consideration. Recommendations are given on the selection of the size of the switch current. The amplitude of the GTA rectangular pulse of any polarity was continuously adjustable with a multireverse potentiometer. The time drift of the GTA in 8 hrs of operation was 0.005% and the temperature instability was 0.002%/°C. (tr-auth)

9784 ENERGY MASS SPECTROMETER FOR LOW ENERGY IONS. Vaisberg, O. L.; Polenov, B. V.; Khazanov, B. I. Yadern. Priborostr.; No. 14, 97-102(1971). (In Russian).

The construction principles and structural plans of mass spectrometers for low-energy ions, designed for the measurement of the energy spectra of protons, α particles, and He^+ ions in plasma flow, are examined. The technical characteristics and operating regime of the instruments are indicated. (tr-auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstract 9769.

9785 PRESENT STATE OF THE GAS DIFFUSION PLANT PROJECT OF THE CEA. Coates, J. H.; Leduc, C.; Mezin, M. (Commissariat a l'Energie Atomique, Paris). Energ. Nucl. (Paris); 14: No. 4, 268-72(Jul 1972). (In French).

In 1967 it was decided to initiate research towards the development of gas diffusion plants for power reactors. The equipment of a small stage (UPE-G) defined in 1968 in view of the construction of a plant on the national scale was constructed between 1969 and 1970. Subsequent tests were carried out. The equipment of the large stage (USG) was defined in 1969 in view of constructing a multinational plant for civil purposes. This stage was constructed between 1970 and 1971. Subsequent tests were carried out. An intermediate size stage (UTG) developed from studies made on previous stages enabled an assembly having a basic yield in excess of 94% to be realized. A detailed technical report (feasibility studies etc.) was prepared. Agreements were obtained in relation to the economic outlook. It is envisaged that all the relevant reports will be available before 1973 and that the decision to construct the plant will be made before 1974. The capacity of the plant is adapted to meet the demands envisaged in the early nineteen eighties. (France)

9786 URANIUM ENRICHMENT. A Report of an Ad Hoc Forum Policy Committee. New York; Atomic Industrial Forum, Inc. (1972). 150p. $20.00.

Results of studies of μ separative work capacities by independent committees are presented. The results are summarized in sections on domestic and overseas requirements and capabilities, economic considerations, and access to enrichment technology. (J.R.D.)

9787 DUAL TEMPERATURE FIXED CARBON BED HEAVY WATER CONCENTRATION PROCESS. Broughton, D. B. (to Universal Oil Products Co.). U. S. Patent 3,700,417. 24 Oct 1972. Filed 4 Nov 1968.

A process for the concentration of a deuterium-containing water stream from a mixture of natural water is described. A feed stream is contacted with an adsorbent at relatively low temperature conditions to effect adsorption of heavy water by the adsorbent. The heavy water is recovered in a relatively high temperature desorption step. The process is operated in a continuous manner with the general net flow of feed being countercurrent to the adsorbent. (Official Gazette)

9788 DIFFUSER ASSEMBLY. Gasc, Henri (to Commissariat a l'Energie Atomique). French Patent 2,102,760. 7 Apr 1972. Filed 20 Aug 1970. (In French).

A diffuser assembly for isotopic separation is presented. It consists of a rigid central structure and a parallel array of tubular barriers situated in a wall defining a sealed compartment. The barriers are connected at one end to a tubular plate fixed to the structure and to the wall, and at their other end to a free tubular plate mounted on the structure and connected to the wall by a flexible joint. The barriers open out as they cross the tubular plates. The free plate is subjected to a pressure which tends to push it towards the fixed plate. These forces are distributed in the barriers; the rigid structure avoids any bending of the barriers. (France)

Isotopic Power Sources

Refer also to abstracts 9460, 9478–9481, 9483, 9484, and 9941.

9789 IMPLANTABLE SYSTEMS USING METALLIC THERMOELECTRICS. Hursen, T. F. pp 3,1-5 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Described are the performance characteristics of a radioisotope powered cardiac pacemaker as an example of a completely implantable system that uses metallic thermocouples as the means of converting the decay heat of plutonium-238 into a useful electrical output. Shock and vibration characteristics for implantable systems of this type are also examined, including test data obtained using complete ^{238}Pu fueled systems. (auth)

9790 REQUIREMENTS, DESIGN, AND PERFORMANCE OF A CONTROL SYSTEM FOR A BRAYTON POWER SYSTEM. Thomas, R. L.; Bilski, R. S.; Wolf, R. A. (Lewis Research Center, Cleveland). pp 4,10-17 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The NASA Lewis Research Center is developing a Brayton Space Power System for future manned space missions. Discussed are the requirements, design, and performance of a Brayton control system. The control system provides the controls and displays required for power system startup, shutdown, and steady-state operation. Also provided is automatic power system protection in the event of engine malfunctions. The control system is designed for a minimum 5-year continuous operation. To achieve this, special circuits and redundancy have been included in the control system to insure continued safe power system operation even in the event of any single component failure. The control system consists of a signal conditioner connected to a control panel by a transmission cable. The signal conditioner mounts on the power conversion system and the control panel is located in a remote control room. One of the two systems delivered to NASA has successfully been used to operate a complete Brayton Power System for over 2000 hours including 12 start-stop cycles. (auth)

9791 DESIGN DESCRIPTION AND PERFORMANCE TEST RESULTS FROM TWO IDENTICAL BRAYTON HEAT EXCHANGER UNITS. Kaykaty, G. N. (Lewis Research Center, Cleveland). pp 4,27-33 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Two identical Brayton-cycle heat exchangers, each consisting of a high performance recuperator, a heat-sink heat exchanger, and interconnecting ducting, have been tested in combination with a Brayton turbine, alternator, and compressor. One test installation comprised the gas loop of the Brayton engine; the other was a complete Brayton engine containing all the system components with the exception of the heat source and radiator which were simulated. The design of the unit is described, and the results of the tests are compared to the anticipated-off design performance. (auth)

9792 INTEGRATION OF AN ISOTOPE BRAYTON POWER SYSTEM WITH A LIFE SUPPORT SYSTEM. Deyo, J. N.; Klann, J. L.; Bilski, R. S. (Lewis Research Center, Cleveland). pp 4,62-8 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

An analytical study was conducted to determine the feasibility of using an isotope Brayton power system to supply both the electrical and thermal needs of an integrated life support system. The study was conducted as a joint effort by staff members of the NASA-Lewis and NASA-Langley Research Centers. Emphasis was placed on studying the steady-state and transient interactions that would result from thermal integration of the two systems. Results of the study show that thermal integration can be accomplished most flexibly by extracting heat in the Brayton power system's waste heat loop through the use of an auxiliary liquid-to-liquid heat exchanger. Thermal transient effects on both systems are within operating tolerances. However, to provide the life-support-system process heating temperature requirement will necessitate operating the power system compressor inlet temperature about 40°F above the existing design point of 80°F, thereby reducing the calculated power system conversion efficiency from 0.29 to 0.27. Hardware modifications to permit integration were examined and found to be minor. Both systems can be made electrically compatible by the addition of a frequency converter. (auth)

9793 EXPERIMENTAL OPERATION OF CONSTANT TEMPERATURE HEAT PIPES. Harbaugh, W. E.; Eastman, G. Y. (RCA Corp., Lancaster, PA). pp 7,1-7 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The development and testing of a number of heat pipes for various applications which employ an inert gas reservoir to

maintain uniform operating temperature are reported. The fundamental principles of this mode of operation are discussed and several constant temperature heat pipe systems are described. These include constant temperature heat pipes for high temperature thermionic conversion systems, thermoelectric conversion systems, and flame-fired Rankine systems. Particular emphasis is given to a series of potassium/nickel constant temperature heat pipes which were tested for periods up to 35,000 hours. The capability of the constant temperature heat pipe to maintain uniform electrical output from a thermionic energy conversion system heated by a decaying radioisotope source is demonstrated. (auth)

9794 AEROTHERMAL DESIGN CONSIDERATION OF A HIGH TEMPERATURE RADIOISOTOPE FUELED HEAT SOURCE. Quinn, J. E.; Knight, D. D. (General Electric Co., Valley Forge, PA). pp 8.1-6 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The design of high temperature energy conversion systems such as a silicon germanium radioisotope thermoelectric generator (RTG) requires the development of an advanced heat source design. The heat source must be designed to survive a wide range of re-entry conditions prior to committing the unit to actual flight. The aerothermal design approach for a typical advanced heat source is described. Included is a discussion of such factors as determination of critical re-entry conditions; and of analyzing re-entry thermal response. A typical application of this method to a heat source design is presented. (auth)

9795 LIGHTWEIGHT, LOW BALLISTIC COEFFICIENT, RADIOISOTOPE FUELED CAPSULE PROTOTYPE DEVELOPMENT PROGRAM. Postula, F. D.; Elsner, N. B.; Emken, M. R. (Gulf General Atomic Inc., San Diego, CA). pp 8.7-11 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A program was completed to develop a capsule which would provide safe containment of a 700 W(t) radioisotope heat source using PuO_2 microsphere fuel. The final design is spherical, employs a tantalum alloy refractory structure and can readily be scaled over the power range from 500 to 1500 W(t). An extensive material evaluation testing program was undertaken to establish hafnia and pyrolytic carbon coatings for thermal protection and tungsten coatings for material compatibility. Prototype capsule tests were conducted to verify the design. There were: launch vibration simulation, solid propellant fire exposure tests, hyperthermal reentry simulation tests, subsonic drag drop tests, and rocket sled impact tests. (auth)

9796 OPTIMIZED ALPHA-EMITTING ISOTOPE HEATERS. Barsell, A. W.; Smith, T. H. (McDonnell Douglas Astronautics Co., Richland, WA). pp 8.12-18 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Potential advantages of radioisotopes over other energy sources for use in spacecraft thermal control and life support systems can be more rigorously evaluated through design optimization. Equations are developed to optimize the structural shell size and thickness, as well as the insulation thickness, for an alpha-emitter isotope heater. The design is constrained to provide helium pressure containment at maximum credible (reentry) temperatures. Computer solution yields minimum weight design conditions. The method includes a weight function mapping about the minimum point and is sufficiently general that shielding, impact, or other safety constraints may be added. Application to typical heater designs indicates that the optimum void-to-fuel ratio is strongly dependent on insulation effectiveness, reentry heating, and containment shell material strength. (auth)

9797 DEVELOPMENT OF SMALL RADIOISOTOPE HEATERS. Smith, T. H.; Hulin, M. W.; Barsell, A. W. (McDonnell Douglas Astronautics Co., Richland, WA). pp 8.19-29 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A design study was conducted to determine potential applications of small (1 to 50 watt) radioisotope heaters in manned spacecraft thermal control and life support systems and develop designs for an optimum group of heaters to fulfill a maximum number of applications with mission times from 14 days to 5 years. Thirty-seven potential application areas were identified requiring up to 300 heaters ranging in size from less than 1 to over 100 watts. Safety and design criteria were selected and reference heater designs developed. Optimization analysis indicated that two heater sizes, 10- and 50-W, and two fuels, promethia and plutonia, would most efficiently meet the majority of identified applications. The designs provide a high probability of fuel containment under all mission operations and environments. (auth)

9798 KERNEL MODULAR POWER FOR SPACE STATION AND BASE. Ruehle, W. G. (Aerojet Nuclear Systems Co., Sacramento, CA). pp 8.30-4 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Recent space electrical power generator studies have indicated that minimum specific weight is achieved with a ^{60}Co kernel of about 60 kW(t). This discovery led immediately to a modular approach to heat source design from about 10 kW(e)-y to the limit of existing ^{60}Co production capacity (well over 1000 kW(e)-y. Since space base, space station, and experiment module power requirements fall within this energy range, the modular heat source—a cluster of identical ^{60}Co kernels—provides a single design solution. The modular kernel is described and development requirements discussed and applied to the design to size various types of dynamic power systems for the space station and base. (auth)

9799 PERFORMANCE OF ^{60}Co CAPSULES AT HEAT SOURCE CONDITIONS. Angerman, C. L.; Ross, C. P. (Savannah River Lab., Aiken, SC). pp 8.35-9 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Superalloy capsules containing either unirradiated (^{59}Co) or irradiated (^{60}Co) cobalt metal wafers performed satisfactorily at simulated normal operating conditions of isotopic heat sources. Capsules of Inconel 600, Hastelloy C, Hastelloy X, and Haynes 25 containing ^{59}Co or ^{60}Co were heated in furnaces for 10,000 hr at 900°C and 1000°C. Other capsules of these materials are presently being heated to goal exposures of 50,000 hr. Capsules were evaluated by helium leak tests, dimensional measurements, and metallographic examinations. The metallographic studies measured the reaction between the cobalt and the superalloy capsule and the oxidation of the exterior capsule surface. Additional capsules are being heated to assess capsule behavior under certain accident conditions. These conditions include the loss of cobalt through a defect in the capsule wall and the interaction of molten cobalt and superalloys with tungsten alloys that might be used for shielding containment in heat sources. (auth)

9800 LARGE ^{60}Co HEAT SOURCE FOR TERRESTRIAL POWER CONVERSION SYSTEMS. Kim, C. K.; Chi, J. W. H. (Westinghouse Electric Corp., Pittsburgh). pp 8.40-5 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Man's increasing activities in remote locations and hostile environments such as the Antarctic have created a need for a new class of power supplies for the operation of equipment and instrumentation as well as space heating. The remoteness of such locations poses a problem in fuel resupply and radioisotopic systems are suggested. A conceptual design of a ^{60}Co heat source for the applications mentioned above is presented. ^{60}Co was chosen for a number of reasons which are discussed. The heat source design presented consists of a two-pass, gas-cooled device. Special features of the design include the following: capability for on-site refueling and refueling without interrupting normal coolant flow; and capability for passive, sustained emergency cooling during loss-of-coolant accidents. A detailed description of the heat source design is presented. Typical operating conditions have been calculated for a 30 kW(t) reference heat source. (auth)

9801 RESULTS AND EVALUATIONS OF THREE YEARS OF DEVELOPMENT ON A HIGH TEMPERATURE REFRACTORY ALLOY RADIOISOTOPE FUEL CAPSULE. Botts, W. V. Jr.; McCourt, P. E. (Atomics International, Canoga Park, CA). pp 8.51-3 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

A symmary is presented of several technological developments which represent a major step in the direction of providing high-performance space RTG's. The AEC's Large Radioisotope Heat Source Capsule Program has, in three years, reduced to qualified hardware a concept which offers large design and safety margins. The technology is now available from which high performance heat source capsules can be designed and qualified with minimum risk. The range of applicability is from 1500 to 3000°F and encompasses TE, Rankine, and Brayton system capabilities. (auth)

9802 FABRICATION AND SAFETY TESTING OF SPHERICAL SUPERALLOY NUCLEAR HEAT SOURCES. Parker, A. J. Jr. (Hittman Associates, Inc., Columbia, MD); Tuttle, J. R. pp 8.54-61 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Work performed to fabricate and safety test spherical superalloy nuclear heat sources is described. The concept of sequential safety testing was used. The accomplishments include design, fabrication, and safety testing of full size and subsized models to appropriate simulated abort environments. (auth)

9803 ISOTOPE HEAT SOURCE INTEGRATED WITH A 7 KW_e TO 25 KW_e BRAYTON CYCLE SPACE POWER SUPPLY. Ryan, R. L. (Avco Systems Div., Wilmington, MA); Graham, J. W.; Coombs, M. G.; Bloomfield, H. S. pp 12.80-7 of Energy 70, Proceedings, Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol. 2).

A concept for a power supply employing an isotope heat source integrated with a 7 kW(e) Brayton cycle space power supply is presented. This concept was developed for application to an advanced Manned Orbiting Laboratory (MOL) concept. Incorporation of the 6600 pound power supply in the MOL was shown to be feasible. A concept is also presented for a 25 kW(e) power supply employing two 12.5 kW(e) isotope/Brayton cycle units for application in a manned space station. (auth)

Radiation Sources

Refer also to abstract 10864.

9804 (GULF-RT-A-12330) ^{252}Cf DEMONSTRATION CENTER. Quarterly Progress Report, July 1, 1972-September 30, 1972. John, Joseph (Gulf Radiation Technology, San Diego, Calif.). 17 Oct 1972. Contract AT(38-1)-730. 20p. Dep. NTIS.

The activities of the Californium-252 Demonstration Center which was recently established jointly by Gulf Oil Corporation and the AEC in San Diego, California, are summarized. Topics include publicity, information meeting, contacts, programs approved, facilities of the center, and sources at the demonstration center. (W.H.K.)

Industrial Uses

Refer also to abstracts 9439 and 9833.

9805 (CEA-CONF-2053) DEVICE FOR MEASURING FLUID-TIGHTNESS USING RADIOACTIVE TRACERS. Mayet, R.; Margrita, R.; Mornas, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb 1972. 6p. (In French). (CONF-720574-2). Dep. NTIS (U. S. Sales Only).

From Spring meeting of the Mechanical Engineering Development Group; Paris, France (16 May 1972).

A device utilizing radioactive tracer elements to check the sealing of vessels is described. This apparatus enables leaks as small as 10^{-7} gram of water per day from elastomer joints under a pressure of 100 bars, to be detected. It can be used to ensure the fluid-tightness of underwater vessels. This measurement sensitivity is obtained by labeling the pressurizing fluid (water) with tritium and measuring the activity penetrating the joint. (auth)

9806 MEASUREMENT OF MOISTURE IN WOOD CHIPS. Gislerud, O. (Norske Skogforsoeksvesen, Vollebekk, Norway). Norsk Skogind.; 26: No. 12, 346-8(1972). (In Norwegian).

Determination of moisture content in wood chips is required by the timber processing industry both for reasons of process control and raw material purchasing. For purchase of material by weight faster and simpler methods than the traditional drying and weighing method are desirable. Changes in the present method can increase capacity and reliability to some degree. Here a reduction of drying time by using smaller samples, higher temperature and more advanced weighing and registering equipment, is especially reflected on. At present there are no simple and inexpensive methods for instantaneous measurement of wood chip moisture with the same accuracy. Those alternatives which seem most promising are capacitance methods, measurement with radioisotopes and possibly measurement by the NMR method. (auth)

9807 METHOD FOR MAKING HIGH TEMPERATURE INSULATING COMPOSITIONS AND SAID COMPOSITIONS. Kuhar, G. A. (to Goodyear Tire and Rubber Co.). U. S. Patent 3,699,023. 17 Oct 1972. Filed 14 May 1968.

A method for preparing a high-temperature insulator is described. A reaction mixture of a polyester polyol, an organoperoxide, an organoisocyanate, and a filler having a resistance to burning is set and cured at a temperature no greater than 250°F for 10 to 20 h. The mixture is then cured for 10 h at 300°F or an ionizing radiation treatment of about 5 to 30 megarads. (Official Gazette)

9808 ELIMINATION OF ELECTRIC CHARGES ON POWDERS BY THE USE OF BETA PARTICLES. 2. Sakanushi, K. (Research Inst. of Industrial Safety, Tokyo). Funtai Kogaku; 8: No. 12, 79-81(Dec 1971). (In Japanese).

An experimental study was made on elimination of electric charges from naturally falling powder. Wheat flour was allowed to fall from a sifter through a silk screen into a Faraday cage. Irradiation with beta particles was made in course of the falling using a ^{90}Sr source. The amount of electric charge increased with decreasing powder size when the irradiation was not made. Under irradiation the percentage of the remaining electric charge increased with increase of falling electric charge per unit time and unit area. When the falling rate of charged particles was very small, the remaining electric charge became negative because of the β-irradiation. With an increase of the rate, it soon reached 0, increased rapidly, and then gradually. The electric charge decreased linearly and increased with weight of the falling powder per unit area and unit time. The gradient of the lines varied with electric charge density, namely, the electric charge per unit weight. Percentage of the charge elimination was independent of the electric charge density. (Japan)

LIFE SCIENCES

9809 (TID-4060(2nd Ed.)) RESEARCH AND DEVELOPMENT IN PROGRESS: BIOMEDICAL AND ENVIRONMENTAL RESEARCH PROGRAM. (Division of Biology and Medicine (AEC), Washington, D. C. Technical Information Center (AEC), Oak Ridge, Tenn.). Dec 1972. 369p. Dep. NTIS.

Indexes prepared by Technical Information Center (AEC), Oak Ridge, Tenn.

Abstracts of 1476 research projects conducted under contract with the Division of Biomedical and Environmental Research of the United States Atomic Energy Commission are presented. The following areas of investigation are represented in the projects: interactions of radiation with biological systems including effects of radiation on living organisms, molecular and cellular radiobiology, and radiation genetics; assessment, evaluation, and control of radiation exposure to man and his environment including exposure to external and internal radiation, combating detrimental effects of radiation, chemical toxicity, land and freshwater environmental sciences, marine sciences, atmospheric sciences, nuclear energy civil effects, radiological physics, health physics, and instrumentation; and beneficial applications of radionuclides and radiation including nuclear medical research, biological and agricultural research, and irradiated foods. Contractor, principal investigator, and subject indexes are included. (E.R.B.)

Radiation Effects on Biochemicals

Refer also to abstract 9833.

9810 (IAEA-R-678-F) RESEARCH INTO AROMA CHANGES IN IRRADIATED FOODSTUFFS. Final Report for the Period 1 September 1968-30 September 1971. Barrera Pinero, R.; Gasco Sanchez, L.; Valverde Garcia, F. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 140p. (In Spanish). INIS.

Changes in aroma and flavor may be produced in some food products preserved by ionizing radiation. Hitherto, detection of these alterations are based on sensory evaluations which are discernible to the consumer's senses. These subjective evaluations vary with the custom, social status and conditioning experience of the tester and are therefore of little value. Development of chemical methods to detect the changes in aroma and flavor of irradiated food products is needed for accurate evaluations of the organoleptic properties of the irradiated products. Investigations were undertaken to determine chemically the aroma constituents in non-irradiated and irradiated fish samples by gas chromatography, mass spectrometry, and infrared spectrometry. Fish fillets were γ irradiated using ^{60}Co source at various dose levels ranging from 0.3 to 6 Mrad. Analysis of the irradiated samples was made in the raw state as well as after boiling. It was found that irradiation of fish at the dose range tested resulted in the formation of radiolytic carbonyl compounds, including ethanol, propanol (or acetone), methanol, methyl-ethyl-acetone, isopentanol, (or diethyl-acetone) pentanol, hexanol, heptanol and nonanol. Likewise the irradiation process resulted in the formation of methyl mercaptane as well as that of dimethyl disulphide. Therefore, the presence of these carbonyl compounds in fish, which did not originate as a result of putrefaction, can safely indicate its preservation by radiation. (auth)

9811 (ORO-2832-98) RADIATION AND BIOPHYSICAL STUDIES ON VIRUSES AND CELLS. Progress Report, October 16, 1971-October 15, 1972. Cole, Arthur (Anderson (M. D.) Hospital and Tumor Inst., Houston, Tex.). 1972. Contract AT(40-1)-2832. 135p. Dep. NTIS.

The induction of double-strand breaks of DNA in isolated nuclei from cultured Chinese hamster interphase cells following exposure to low-voltage electron beams was studied. It was found that low-energy beams (500 to 1000 eV) were ten-fold more efficient for producing breaks than penetrating beams. The effects of 25 and 30 kR γ radiation from a ^{137}Cs source and fission neutrons from a ^{252}Cf source on the structure of DNA and chromatin were compared, using purified DNA and chromatin solutions from rat thymus. Strand breaks in DNA and changes in the viscosity and denaturation of DNA and chromatin are reported. An x-ray microprobe adapted for use with an electron microscope for the study of nuclear, chromosomal, and cytoplasmic components of cells is described. A list of publications during the 12-month period covered by the report is included. (C.H.)

9812 STRAIN OF ESCHERICHIA COLI WITH MINIMUM POSTIRRADIATION DEGRADATION PROPERTIES. Horan, P. K.; Hird, K.; Pollard, E. C. (Pennsylvania State Univ., University Park). Radiat. Res.; 52; No. 2, 291-300(Nov 1972).

A strain of Escherichia coli was isolated that possesses minimum postirradiation degradation properties. Starting with E. coli B_{s-1}, mutational selection procedures were used to select for cells that do not degrade their DNA. Our strain (PHH1) does not degrade its DNA when exposed to 20 krad or less. It has a high survival capacity, even greater than E. coli B/r. This strain has an OER of about 3.0. The insensitivity of this cell to radiation-induced degradation suggests that it is a prime candidate for the study of relative sensitivities of the molecular apparatus of cells to ionizing radiation. (auth)

9813 X-RAY INDUCED DNA DEGRADATION IN RADIOSENSITIVE STRAINS OF ESCHERICHIA COLI K12. Youngs, D. A. Ann Arbor, MI; Univ. of Michigan (1971). 126p. University Microfilms Order No. 72-29,243.

Thesis.

Several mutants of Escherichia coli have previously been isolated which are sensitive to the lethal effects of ionizing or ultraviolet irradiation and which degrade their DNA extensively after such irradiation. This paper involves an examination of the degradation response of these strains to x-irradiation. The degradation response of exr, recA, polA, ras, and uvrD mutants of Escherichia coli K_{12} was examined. The relationship of the degradation process to the DNA and protein synthetic processes was investigated by observing degradation in each strain in the presence of nalidixic acid (NAL) and chloramphenicol (CAP), inhibitors of these processes. The degradation response of each strain was examined after growth in enriched minimal medium (EM9) and nutrient broth (NB) after exposures ranging from 2 to 40 KR. The results show that degradation was increased by CAP at low exposures in wild-type, polA, and ras strains after growth in either EM9 or NB medium. NAL had no effect, except in the ras strain where it slightly decreased degradation. CAP decreased survival after a 5 KR exposure in these strains but NAL had no effect. CAP and NAL decreased degradation in the recA and exr strains in either EM9 or NB medium and also in the uvrD strain when growth was in NB medium. When the uvrD strain was grown in EM9 medium, no effect of NAL and only a slight inhibitory effect of CAP on degradation were observed. CAP and NAL increased survival in the exr strain, had little effect in recA, and decreased survival in the $uvrD_3$ mutant after a 5 KR exposure. When a $recB_{21}$ or $recC_{22}$ mutation was present in addition to the original radiosensitizing mutation, all strains except $uvrD_3$ showed greatly decreased degradation. The $uvrD_3$ strain still degraded DNA extensively, though at a somewhat reduced rate. The following conclusions were made: Extensive degradation in the polA strain probably occurs because of a failure to terminate degradation involved in the excision repair process. The recA and exr strains may degrade DNA extensively because of inability to terminate degradation involved in the recombination (rec) repair process. The ras strain may be deficient in termination of degradation in either excision repair or rec repair. The uvrD strain may possess a mutant nuclease which is able to compete with the recB-recC nuclease in the excision repair and rec repair processes. The recB-recC nuclease is intimately involved in x-ray induced DNA degradation, probably in the excision repair and rec repair processes. (Diss. Abstr.)

9814 INHIBITION OF DNA REPAIR REPLICATION BY DNA BINDING DRUGS WHICH SENSITIZE CELLS TO ALKYLATING AGENTS AND X RAYS. Gaudin, David; Gregg, R. S.; Yielding, K. L. (Univ. of Alabama, Birmingham). Proc. Soc. Exp. Biol. Med.; 141: No. 2, 543-7(Nov 1972).

Investigations with drugs which sensitize tumor cells to the action of alkylating agents or ionizing radiation indicate that this sensitization is the result of DNA repair inhibition. A number of DNA binding drugs which sensitize living cells to the action of alkylating agents and x rays were shown to inhibit the uv-stimulated incorporation of tritiated thymidine by normal human lymphocytes incubated in the presence of hydroxyurea. It is proposed that such DNA repair inhibiting drugs may have a role in tumor therapy when used in conjunction with alkylating agents or x rays. (auth)

9815 ANOMALY IN THE PYRIMIDINE NUCLEOTIDE BLOCK DISTRIBUTION IN DNA IN LEUKOSES AND RADIATION INJURY. Kritskii, G. A.; Aleksandrov, S. V.; Koromyslov, G. F.; Grishchenko, M. N. (Inst. of Biochemistry, Moscow). Dokl. Akad. Nauk SSSR; 206: No. 1, 230-2(1 Sep 1972). (In Russian).

Injury to the DNA structure in mammals was evaluated through DNA analysis in malignant cells using the block method. DNA structures of the leukocytes in the blood of rabbits, mice, and cattle with spontaneous leukemia were compared with the peculiar changes in DNA structure resulting from radiation damage. DNA of normal leukocytes and in leukemia possessed the same fractions of pyrimidine nucleotide blocks which appear in DNA from other sources. An anomaly in the original DNA structure of leukocytes from leukemic animals was apparent from descending paper chromatography tests. (K.S.W.)

9816 EFFICIENCY OF REPAIR OF UV INDUCED DAMAGE IN BACTERIA: A PHYSICAL MODEL. Waldman, D. R. Jamaica, NY; St. John's Univ. (1972). 80p. University Microfilms Order No. 72-31,044.

Thesis.

The pyrimidine dimer is known to be the principal cause of uv-induced death in Escherichia coli bacteria. Repair, by means of the enzymatic excision of dimers, modifies the effects of the radiation. Different strains of E. coli exhibit a wide variation in sensitivity to uv radiation. In order to explain this variation, a model, incorporating the known phenomenon of uv induced pyrimidine-protein cross-links, is proposed. Differences in uv sensitivities are explained in terms of differences in pyrimidine contents of the non-active regions within the DNA sites associated with the production of repair enzymes. The theory of analogous systems, in which similar systems undergoing equivalent processes are compared, then provides a quantitative check of the proposed model. As a result of the application of this theory, unique sets of integer values for the numbers of thymine and cytosine bases at the repair sites are found, lending convincing support to the model. This technique is then extended to another strain using data from a different experiment. Finally, an application of the technique to a strain deficient in the recombination ability lends support to the contention that the repair associated with the recombination ability is also governed by the same model. (Diss. Abstr. Int., B)

Radiation Effects on Cells

Refer also to abstract 9814.

9817 EFFECT OF X RAYS ON LABELLING PATTERN OF M_1 AND M_2 CHROMOSOMES IN CHINESE HAMSTER CELLS. Gatti, M.; Olivieri, G. (Univ., Rome). Mutat. Res.; 17: No. 1, 101-12(Jan 1973).

Chinese hamster cells (line CHEF-125) were cultured for 1 to 4 hr in the presence of tritiated thymidine (^{3}HTdR). Immediately after the end of the treatment with ^{3}HTdR or 4 hr afterwards, some cultures were irradiated with x rays, while others served as controls. Analysis of colchicine-C anaphase of M_1 and M_2 cells showed that: (a) in the M_1 chromosomes the x rays produced a significant departure from a 1:1 ratio of the number of silver grains counted on the sister chromatids; and (b) in the M_2 chromosomes the x rays increased significantly the frequency of sister-chromatid exchanges and of isolabelling regions. Subchromatid exchanges involving a single polynucleotide strand may be induced by x rays. These exchanges would cause inequality of labelling over M_1 sister chromatids and isolabelling in the M_2 chromosomes. (auth)

9818 INFLUENCE OF IRRADIATION OF SPLENIC AND LIVER NUCLEI ON THE INCORPORATION OF ^{14}C- LABELLED AMINO-ACIDS IN THE TOTAL ALBUMIN. Blochina, V. D.; Romancev, E. F.; Sidorov, I. A.; Rogozkin, V. D. Radiobiol.-Radiother.; 13: No. 5, 557-63(1972). (In German).

Isolated splenic and liver nuclei were irradiated with γ rays and x rays in doses of 500 to 30,000 R. The incorporation of ^{14}C lysine and ^{14}C-leucine in the total albumin of the nuclei was studied in vitro during their incubation. It could be shown that the irradiation of the nuclei causes a considerable inhibition of the incorporation (up to 50 to 60%) of ^{14}C-labeled amino-acids into the albumin of the splenic nuclei and a less important inhibition of the incorporation (up to 30 to 35%) of the radioactively labeled material into the albumin of the liver nuclei. The irradiation of the nuclei up to 500 R leads to a nearly linear increase of the inhibition of the incorporation of the radioactively labeled material whereas a further increase of the dose up to 30,000 R increases less the inhibitory influence on the splenic as well as on the liver nuclei. If the nuclear suspension after the irradiation with high doses is left for 1 hr, an intensified inhibition of the albumin synthesis is caused. The irradiation of the nuclei with a low dose rate (60 R/min) leads to a less high impairment of the activity of albumin synthesis of the splenic nuclei. (auth)

9819 STUDY OF THE EFFECTS OF LOW, MEDIUM, HIGH, AND ULTRA-HIGH DOSE RATE X-RADIATION ON THE CHROMOSOMES OF HUMAN LYMPHOCYTES. Michelsen, Arve. Baltimore; Johns Hopkins Univ. (1970). 175p. University Microfilms Order No. 72-28,966.

Thesis.

The hypothesis which continues to best fit experimental data bearing on the nature of the injury induced in a living organism by ionizing radiation, identifies the cell nucleus as the target, and ascribes subsequent damage to various alterations of the genetic material. Considerable knowledge has been accumulated from previous studies of the effect of radiation quality and dose on the frequency of chromosomal aberrations. The relationship between chromosome exchange frequency and dose rate has, however, not hitherto been firmly established. The present investigations utilize human lymphocytes taken from peripheral blood and irradiated with x rays at dose rates ranging from 0.063 to 5.35×10^{10} R/sec, a span of almost 12 orders of magnitude. All exposures were administered well within the repair time period applicable to the G_1 stage of the cell cycle. It was observed that for a given dose, the radiation effect is independent of dose rate over the range from 0.063 to 4×10^6 R/sec. Ultra-high dose rates on the order of 5×10^{10} R/sec resulted in the two-hit chromosome aberration frequency exhibiting a decrease of approximately 40%. A normal oxygen effect was still observed at a dose of approximately 100 R, and a rate of about 5×10^{10} R/sec. Furthermore, mitotic delay appears to be independent of dose rate over the entire range investigated. (Diss. Abstr. Int., B)

9820 RADIOSENSITIVITY OF CULTURED MAMMALIAN CELLS EXPOSED TO SINGLE HIGH INTENSITY PULSES OF ELECTRONS IN VARIOUS CONCENTRATIONS OF OXYGEN. Epp, E. R.; Weiss, H.; Djordjevic, B.; Santomasso, A. (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res.; 52: No. 2, 324-32(Nov 1972).

The oxygen effect in cultured HeLa cells exposed to single short (3 nsec) pulses of electrons from a field emission source was investigated. Cellular radiosensitivity as measured by the ability of surviving cells to form colonies was determined experimentally over a range of concentrations of oxygen with which the cells were initially equilibrated. Cells attached to a Mylar disc were irradiated in a Petri dish from which the medium was removed. Prior to irradiation, it was found essential to transfer the disc from the dish in which plating originally took place to a new dish; this served to avoid any possible influence on experimental data by migrant cells shielded from the low energy electron beam at the edge of the dish. A family of breaking survival curves for the various initial oxygen concentrations was observed. These curves are similar to those previously measured for E. coli B/r by this laboratory; however, because of the higher radiosensitivity of mammalian cells, the curves break at values of absorbed dose and oxygen concentration much lower than for bacteria. The data appear to be reasonably consistent with a physicochemical mechanism involving the radiochemical depletion of oxygen previously invoked for the pulsed irradiation of bacteria. (auth)

9821 REPAIR OF SUBLETHAL AND POTENTIALLY LETHAL X-RAY DAMAGE IN SYNCHRONOUS CHINESE HAMSTER CELLS. Winans, L. F.; Dewey, W. C.; Dettor, C. M. (Colorado State Univ., Fort Collins). Radiat. Res.; 52: No. 2, 333-51(Nov 1972).

Mitotic cells were selected from asynchronous cultures and x-irradiated either in mitosis, G_1, or S phase. Repair of sublethal damage was measured by the increase in survival that occurred as two doses of radiation were separated by incubation at 37 or 20°C. Repair of potentially lethal damage was measured by the increase in survival that occurred as the cells were held at 20°C after a single dose. The maximum amount of repair of sublethal damage during S phase increased with dose (the dose modifying factor, DMF, increased from 1.05 or 1.14 for 500 rads to 1.11 or 1.20 for 1000 rads for treatment at 20 or 37°C, respectively), but did not result in the survival expected if all of the sublethal damage was repaired. The rate of repair ($T_{\frac{1}{2}}$ of 15 to 20 min) was the same at either 20 or 37°C and was independent of dose. The rate of repair of potentially lethal damage during S phase was the same as that for repair of sublethal damage, but the magnitude of repair of potentially lethal damage (DMF of 1.08 independent of dose) was about one-half that of the repair of sublethal damage. The G_1 cells had the capacity to repair both sublethal and potentially lethal damage, but mitotic cells could neither repair potentially lethal damage nor accumulate sublethal damage, as evidenced by the lack of a shoulder on the survival curve. However, when cells were irradiated in mitosis and allowed to move slowly into G_1 at 20°C before they were placed at 37°C, repair of potentially lethal damage occurred, and the survival increased and corresponded to that expected for cells irradiated in G_1. Furthermore, when S phase cells were treated with hypertonic medium,

both types of repair were blocked. From these studies and reports of the positive correlation between chromosomal damage and cell killing, the hypothesis was presented that potentially lethal lesions result from the interactions of sublethal lesions in chromatin structures. Due to competition between fixation of damage and repair of damage, potentially lethal lesions are either rapidly converted ($T_{½}$ of 2 min) at 37°C into lethal lesions, or are repaired at 20°C because fixation processes are inhibited. (auth)

9822 ENHANCEMENT OF X-RAY DAMAGE IN SYNCHRONOUS CHINESE HAMSTER CELLS BY HYPERTONIC TREATMENTS. Dettor, C. M.; Dewey, W. C.; Winans, L. F.; Noel, J. S. (Colorado State Univ., Fort Collins). Radiat. Res.; 52: No. 2, 352-72(Nov 1972).

Cells synchronized by the mitotic selection technique were treated with hypertonic medium (525 to 584 mosm from myo-inositol, glucose, sorbitol, KCl, or NaCl) and x-irradiated either in mitosis, G_1, or S phase. The hypertonic treatments did not reduce the plating efficiency of the unirradiated cells, but they did produce radiosensitization (more cell killing and chromosomal aberrations), which increased as the synchronous cells were treated and irradiated in more resistant phases of the cell cycle. For example, treatment of sensitive mitotic cells produced no radiosensitization, whereas treatment of resistant S phase cells, either before or after irradiation, resulted in radiosensitization characterized by dose modifying factors of 1.20 or 1.45 for treatments at 20 or 37°C, respectively. Radiosensitization was associated with condensation of chromatin observed by electron microscopy. At 20°C, the effect of hypertonic treatment was attributed equally to increase in lethal damage and to inhibition of repair at 20°C of potentially lethal damage. Furthermore, a relatively long period of 10 to 20 min was required both for the effect to occur and to disappear once the treatment was terminated. At 37°C, however, the radiosensitizing effect persisted for less than 1 min once the treatment was terminated and was due to an increase in the rapid ($T_{½}$ of 1 to 2 min) fixation of potentially lethal damage. It was postulated that single lesions in chromatin fibers that were packed together within 30 sec after hypertonic treatment interacted to produce potentially lethal lesions. These potentially lethal lesions were then either confirmed at 37°C into lethal lesions or were rapidly converted back into single sublethal lesions when the chromatin was dispersed within 30 sec after transfer of the cells back into isotonic medium. (auth)

9823 CHANGES IN RADIOSENSITIVITY AND DISPERSION OF CHROMATIN DURING THE CELL CYCLE OF SYNCHRONOUS CHINESE HAMSTER CELLS. Dewey, W. C.; Noel, J. S.; Dettor, C. M. (Colorado State Univ., Fort Collins). Radiat. Res.: 52: No. 2, 373-94(Nov 1972).

Chinese hamster Don cells, synchronized by removing metaphase cells from an asynchronous population, were x-irradiated or fixed in different parts of the cell cycle. Radiosensitivity, as measured by chromosomal aberrations, decreased by a factor of 2.6 as the cells moved from mitosis into S phase. This decrease in radiosensitivity correlated well with the dispersion of chromatin, which was visualized and quantitated by electron microscopy. The chromatin consisted of 70-Å fibers, each of which contained two 28-Å fibrils, and the distance, D, between the 70-Å fibers increased from an average value of 142 Å in mitotic cells with condensed chromatin to 196 Å in S phase cells with dispersed chromatin. The value of $1/D^3$ decreased, as for the frequency of aberrations, by a factor of 2.6 as the cells moved from mitosis into S phase. Based on (1) this correlation, (2) an increase in radiosensitivity associated with condensation of chromatin caused by hypertonic treatment, and (3) other observations including the similarity in kinetics for repair of sublethal and potentially lethal lesions, a model was proposed to account for much of the variation in radiosensitivity during the cell cycle. In this model, potentially lethal and lethal lesions result from the interaction of single lesions in the 70-Å chromatin fibers. Interacting lesions may be produced in close proximity to one another by a single dose of radiation, or they may result from single sublethal lesions from one dose interacting with other single sublethal lesions produced by a second dose. Thus, the mitotic cells should be the most radiosensitive cells because their tightly packed chromatin fibers should provide the highest probability for interactions between lesions. However, the increase in radiosensitivity at the G_1/S border must be attributed to other mechanisms. (auth)

9824 BEHAVIOR OF SWINE LEUKOCYTES IN CULTURE AFTER IN VIVO OR IN VITRO GAMMA IRRADIATION. McFee, A. F.; Banner, M. W.; Sherrill, M. N. (UT-AEC Agricultural Research Lab., Oak Ridge, TN). Radiat. Res.; 52: No. 2, 301-8(Nov 1972).

Mature pigs were given 100, 200, 300, or 400 R (midline in air) exposures to gamma radiation at 50 R/min. Leukocyte cultures established from postirradiation blood and from samples simultaneously irradiated in vitro were evaluated at intervals up to 96 hr in culture. White cell counts, the proportion of lymphocytes recovered, and the proportion of viable cells were reduced by irradiation, but not in a dose-related manner. The effects on labeling and mitotic indexes, polyploid rates, and nuclear volume increases were dose dependent. While considerable variability among animals existed, there was a close relationship between the in vivo and in vitro responses of their leukocytes. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 9810, 9812, 9816, and 9856.

9825 CHLORAMPHENICOL EFFECTS ON DNA REPLICATION IN UV-DAMAGED BACTERIA. Doudney, C. O. (Albert Einstein Medical Center, Philadelphia). Mutat. Res.; 17: No. 1, 1-12(Jan 1973).

Increasing uv doses to cultures of Escherichia coli strain B/r decreased progressively the amount of DNA that was formed in the presence of chloramphenicol (160 μg/ml) from the amount formed in unirradiated control cultures in chloramphenicol-containing medium. This is attributed to the progressive inactivation of active sites of DNA replication by uv. In order to form DNA, the bacteria must then replicate from the chromosomal fixed origin, an activity that requires protein synthesis and thus cannot occur in the presence of chloramphenicol. Such damage was shown to be subject to photoreactivation after lower uv doses and thus is the pyrimidine dimer. After higher doses, non-photoreversible lesions began to accumulate so that all such damage became non-photoreversible after 96 erg/mm². The rate of synthesis of DNA in the presence of chloramphenicol was shown to be very close to the rate shown by bacteria incubated in the absence of chloramphenicol, indicating that all active sites of replication remaining after uv damage remain active in the presence of chloramphenicol, as expected if the limiting effect of chloramphenicol is on initiation at the chromosomal origin and not due to reduction in rate of DNA replication. A much lower concentration of chloramphenicol (2 μg/ml) blocking only the chloramphenicol-sensitive event in control of DNA replication described by Ward and Glasser, imposed a limitation in DNA accumulation in the culture of somewhat less than a doubling, as would be expected if the antibiotic at this concentration does not block the chloramphenicol-resistant control event. DNA degradation occurred with incubation of bacteria given a uv dose sufficient to inactivate all active DNA replication sites on their chromosomes, when in medium containing chloramphenicol concentrations (above 20 μg/ml) sufficient to block the chloramphenicol-resistant control event. Such breakdown resulted in death. The damage responsible for such death and DNA breakdown was not photoreversible after this dose, supporting the hypothesis that breakdown results from non-photoreversible inactivation of active DNA replication sites. This was in contrast to increased death in uv-damaged bacteria promoted by nalidixic acid, a specific inhibitor of DNA replication, which could be prevented in part by light exposure after the same uv dose. (auth)

9826 EFFECT OF THE recC GENE IN ESCHERICHIA COLI ON FREQUENCIES OF ULTRAVIOLET-INDUCED MUTANTS. Hill, R. F.; Nestmann, E. R. (York Univ., Toronto). Mutat. Res.; 17: No. 1, 27-36(Jan 1973).

UV induction of Lac^- mutations was compared with uv induction of Mal^+ mutations in E. coli B/r strains differing in the recC gene. The frequency of Lac^- mutants per survivor induced by the same dose was not significantly affected by the recC gene but the percentage of pure rather than sectored Lac^- colonies was greater when the recC gene was present. On the other hand, as reported previously, frequencies of Mal^+ mutants induced by the same uv dose were lower when the strain was recC. The reduction factor was the same as for spontaneous Mal^+ mutants. The difference in the effect of the recC gene on the yields of Lac^- and Mal^+ mutants can be explained by taking into account the influence of lethal sectoring, which introduces an artifact when mutants arising in the recC strain are scored selectively as in the case for Mal^+ mutants, but not when the scoring is non-selective as for Lac^- mutants. Lethal sectoring as indicated by a discrepancy between total cell counts and numbers of colony-formers, was observed for the recC strain growing in liquid minimal medium corresponding to the agar medium used to score Mal^+ mutants but was not observed for the rec^+ strain. Both strains showed lethal sectoring in the liquid medium corresponding to the agar medium used to score Lac^- mutants. The hypothesis concerning the role of lethal sectoring in the selective scoring of mutants arising in a recC

background is supported by evidence concerning the uv induction of mutants in a polAI background. Like the recC gene, the polAI gene did not affect yields of Lac$^-$ mutants. However, unlike the recC gene, the polAI gene has previously been shown not to influence uv yields of prototrophic mutations (scored selectively) and not to cause lethal sectoring except under irrelevant conditions. (auth)

9827 RADIATION INACTIVATION AND RECOMBINATION REPAIR IN BACILLUS SUBTILIS SPORES. Sadaie, Y.; Kada, T. (National Inst. of Genetics, Mishima, Japan). Mutat. Res.; 17: No. 1, 138-41(Jan 1973).

Several recombinationless mutant strains of Bacillus subtilis were isolated, whose spores were more sensitive to uv or γ rays than were spores of wild type bacteria, indicating that certain radiation damage in spores can be repaired through recombination functions. The vegetative cells of recombination-deficient strains were extremely more sensitive to uv irradiation than were their spores. This contrasts with the much smaller difference with γ rays. (E.R.B.)

9828 IONIZING RADIATION-INITIATED DEGRADATION OF DNA IN GERMINATING SPORES. Cyr, W. H.; Pollard, E. C. (Pennsylvania State Univ., University Park). Radiat. Res.; 52: No. 2, 409-18(Nov 1972).

Three different patterns of postirradiation DNA degradation were found in germinating spores. First, when Bacillus subtilis is irradiated as spores, there is little or no degradation. Second, when B. subtilis is allowed to germinate for a period of time less than 40 to 50 min prior to irradiation, there is degradation, but with a lag. Third, when B. subtilis is allowed to germinate for a period of time greater than 40 to 50 min prior to irradiation, there is immediate breakdown of DNA similar to the type found in vegetative cells. The modified pattern of DNA degradation seen in germinating spores is another argument for the hypothesis that the DNA in bacterial spores is in a different physical state from that found in vegetative cells. (auth)

9829 INDUCTION OF RECOMBINATION IN WILD TYPE AND ULTRAVIOLET LIGHT SENSITIVE MUTANTS OF ESCHERICHIA COLI K12 BY CHEMICAL MUTAGENS AND ULTRAVIOLET IRRADIATION. Norin, A. J. Houston, TX; Univ. of Houston (1972). 148p. University Microfilms Order No. 72-31,046.

Thesis.

The frequency of F′ histidine dependent homogenotes arising from histidine independent heterogenotes was increased by N-methyl-N′-nitro-N-nitrosoguanidine, diethyl sulfate (DES), ethyl methanesulfonate (EMS), methyl methanesulfonate (MMS), nitrous acid, 2-aminopurine, uv irradiation and methotrexate. These agents may stimulate recombination by increasing the number of single-stranded regions in the DNA duplex or preventing the closure of these gaps; thus, increasing the probability of synapse between heterologous DNA molecules. At similar survival, MMS induced higher recombination frequencies than EMS, though EMS induced more auxotrophic mutant clones. Methylated bases are more rapidly depurinated than ethylated bases; therefore, depurination-breakage may increase recombination while decreasing mutagenesis. The frequency of induced histidine dependent homogenotes was significantly higher when the his$^-$ allele was located on the F′ factor rather than the chromosome. A mutant of E. coli K12 (uvr C$^-$) which is unable to excise pyrimidine dimers had a higher recombination frequency in response to uv irradiation than an isogenic uvr C$^+$ strain. This result supports the hypothesis that it is primarily the gaps formed in the newly synthesized DNA strand, opposite the dimers in the template, that give rise to recombinant molecules. The uvr C$^-$ mutation altered the distribution of the different types of recombinants; however, the frequency of spontaneous nonreciprocal recombinants was the same as in the isogenic uvr C$^+$ strain. The latter observation suggests that the dark repair system in E. coli is not involved in the formation of nonreciprocal recombinants. A polymerase I (pol I) mutant of E. coli, pol A1$^-$, had a high spontaneous recombination frequency. Recombination, however, was not increased with EMS and only slightly increased with MMS and uv irradiation. The pol A1$^-$ mutant was mutagen-stable to MMS and EMS, but uv irradiation increased the frequency of auxotrophic mutant clones. The mutagen stability may be caused by the increase in sensitivity of the cells to alkylating agents rather than any primary role of the pol I enzyme in the process of mutagenesis. A Hcr$^-$ (uv-host cell reactivationless) mutant of E. coli, syn$^-$, exhibited lower DNA polymerase activity when its crude membrane fraction was compared to that of an isogenic syn$^+$ strain. The syn$^-$ mutation maps at a different position than either pol I or pol III, therefore it may affect pol II activity. Recombination and mutation in syn$^-$ strains was increased by MMS and uv irradiation. EMS and DES increased the frequency of auxotrophic mutant clones but did not stimulate recombination. (Diss. Abstr.)

Radiation Effects on Plants

Refer also to abstracts 9856 and 9874.

9830 (IAEA-R-317-F) ENLARGEMENT AND EVALUATION OF A COLLECTION OF MUTANT TYPES OF PISUM, INVESTIGATIONS ON LIMITING FACTORS IN MUTATION BREEDING. PART OF A COORDINATED PROGRAMME OF RESEARCH ON THE PRODUCTION AND USE OF INDUCED MUTATIONS IN PLANT BREEDING. Final Report for the Period 1 June 1970–31 May 1971. Gottschalk, W. (International Atomic Energy Agency, Vienna (Austria)). Sep 1971. 4p. INIS.

A collection of x-ray and neutron induced mutants of Pisum sativum was further evaluated by crossing, checking offspring segregation, developing lines with a combination of mutated genes and studying the value of such lines for plant breeding. A mutant with high yielding capacity, the fasciated mutant No. 489 C, was found to contain at least 6 simultaneously mutated genes. The disadvantageous characters, tallness and lateness, of this mutant were removed or compensated by crosses with other mutants. The mutated characters' high numbers of ovules per ovary and stem bifurcation were combined without difficulty. Other combinations, however, demonstrated a certain disharmony between genes, resulting in an unexpected decrease in seed production. A clear heterosis effect was observed in all F_1-hybrids, when the fasciated mutant No. 489C was used as one of the parents. A number of Pisum mutants were analyzed for total protein content, protein pattern, and amino acid composition in relation to yielding capacity. Remarkable differences have been found. The mutants will be studied further with regard to interaction of various mutated genes affecting protein quantity and/or quality. (auth)

9831 (IAEA-R-785-F) REPAIR MECHANISMS AND VARIATIONS IN RADIOSENSITIVITY WITHIN THE GENERATION CYCLE OF YEAST CELLS. Final Report for the Period 1 November 1969–30 November 1971. de Langguth, E. N. (International Atomic Energy Agency, Vienna (Austria)). Dec 1971. vp. INIS.

Synchronized cultures of Saccharomyces cerevisiae strains 211 (diploid), 211 p (diploid petite) and 600 (hexaploid) were assayed for their sensitivity to x-ray and uv-irradiation. It was found that a distinct sine-wave pattern of sensitivity is present with maximum resistance at the time of bud initiation and DNA duplication and maximum sensitivity during the interdivision phase of the cell cycle. Hexaploid cells were found to be somewhat more sensitive throughout the cycle than diploid cells and had a longer generation time. In normal strains repair of radiation-induced damage occurred if the cells were held in water for a period of one to four days before assessing survival. In respiratory deficient "petite" strains however a fermentable sugar (glucose) was required in the holding medium before repair could occur. This is believed to indicate an energy-requiring enzymic repair process is present. In support of this it was also found that caffeine, known to inhibit enzymic repair processes, caused all phases of the cell cycle to become radiosensitive. It is concluded that the level of enzymic repair capacity varies during the cell cycle and that this variation is responsible for the differing sensitivities. (auth)

9832 (ORO-2583-10) CYTOLOGICAL STUDY OF RADIATION INDUCED ALTERATIONS IN CYTOPLASMIC FACTORS CONTROLLING MALE STERILITY IN CORN. Progress Report, February 28, 1972–December 1, 1972. Edwardson, J. R. (Florida Univ., Gainesville. Dept. of Agronomy). 1972. Contract AT(40-1)-2583. 20p. Dep. NTIS.

Selections from gamma-irradiated T-type corn have shown resistance to race T Helminthosporium maydis infection, and loss of cytoplasmic sterility factors. Various sources of T-cytoplasm, and standard T-cytoplasm lines treated with chemical mutagens and irradiation, are being examined for sterile, H. maydis resistant segregants. Dominant genes inducing sterility and their suppressors are studied in S-cytoplasmic male sterile corn lines. Cytological and seed transmission studies of Blakeslee's Q-virus are in progress. A search is underway for abnormal appearing sperms. Cytological comparisons of cytoplasmic male sterile and maintainer lines of several species for establishment of consistent differences in cytoplasmic constituents are continuing. Consistent cytological differences between male sterile and normal Vicia faba lines, between male sterile corn lines, and between male sterile and maintainer corn lines have been observed. (auth)

9833 (UH-235-P-5-X-1) DOSIMETRY, TOLERANCE, AND SHELF LIFE EXTENSION RELATED TO DISINFESTATION OF FRUITS AND VEGETABLES BY GAMMA IRRADIATION. Final Summary Report. Moy, J. H. (Hawaii Univ., Honolulu. Coll. of Tropical Agriculture). Dec 1971. Contract AT(04-3)-235. 49p. Dep. NTIS.

Irradiation studies were conducted under USAEC Contract AT(04-3)235, Project Agreement 5 from June, 1964 through June, 1971. Major objective was to determine dosimetry, tolerance dose, quality retention, nutritional adequacy, and post-irradiation changes as related to disinfestation and shelf life extension of fresh fruits and vegetables by gamma irradiation, with special emphasis on tropical products, and oriented towards commercial processing of high quality products for export. Tolerance studies showed papaya (variety Solo), passion fruit (var. yellow), banana (var. Brazilian), and mango (var. Haden) could tolerate to 100 krad; pineapple (var. Smooth Cayenne) and lychee (var. Brewster, Chong-Un-Hung, Groff, Kwai-Mi, Pot-Po-Hung, and Heung-Lai) to 50 krad without surface scalding or bronzing. Sensory qualities of various fruits were retained when irradiated at disinfestation doses and above: papaya (25 to 100 krad), pineapple (25 to 200 krad), mango (33 to 150 krad), banana (25 to 100 krad), lychee (25 to 100 krad). Nutrients in various fruits, such as total and reduced ascorbic acids and carotenoids, were not significantly affected by gamma-radiation treatment at above tolerance dose levels: papaya (150 krad), pineapple (200 krad), and mango (200 krad). Shelf life of color-turning to ¼-ripe papayas was extended for three to three and one-half days when treated with hot water (120°F, 20 min) and 75 krad under laboratory conditions, and was consistently equal to or better than those observed for controls, fumigated or vapor heat-treated fruits in simulated and large-scale shipping studies. Shelf life of mango was extended one to two weeks when irradiated at 75 to 100 krad, followed by storage at 45-55°F, 90% R. H. Other studies on papaya showed: doses up to 100 krad were ineffective in controlling post-harvest diseases caused by seven different fungi; peroxidase activity in papaya was not a sensitive biological index to reflect maturity and post-irradiation changes; a flowery aroma developed in some papayas irradiated at 33, 75, 100 krad, stored at 45 to 50°F, followed by ripening at 70 to 80°F; no gamma-radiation induced growth principles were found in papayas irradiated up to 1 Mrad. Biochemical components or factors such as total and reducing sugars, total soluble solids, titratable acidity, total protein and protease activity, phenolic substances, chlorogenic acid, and anthocyanins, where existed, were not adversely affected in fruits when irradiated up to dose levels indicated: papaya (250 krad); pineapple (200 krad), mango (150 krad) and lychee (50 krad). Shelf life of several other products could be extended by radiation treatment: of ginger and sweet potato, through sprout inhibition, at 1 and 10 krad, respectively; of poi, through control of acid-producing microorganisms at 0.75-1.0 Mrad. The oligosaccharides (raffinose and stachyose) in soybeans, known as gas producing factor, could be substantially reduced through controlled germination with radiation treatment at 250 to 500 krad while retaining the original form of the beans and requiring less time to cook. (auth)

9834 STUDIES ON THE INDUCED POLYEMBRYONY AND TWIN SEEDLINGS IN RICE BY X RAY AND ^{32}P. Majumder, B. (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta); 32: No. 3-4, 105-8(1969).

Dry seeds of the varieties Marichbati and Jhanjee belonging to autumn paddy were irradiated with x-ray (50 kR, 75 kR) and ^{32}P (30 μc/seed). Polyembryony and twin seedlings were isolated in the second and subsequent generations after irradiation. The frequency of occurrence, the growth of seedlings and agronomical behavior of the twin seedlings have been studied. (auth)

9835 EFFECTS OF RECURRENT IRRADIATION ON LATHYRUS SATIVUS LINN. AND HORDEUM VULGARE LINN. Das, A. (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta); 32: No. 3-4, 75-92(1969).

Soaked seeds of Lathyrus sativus and Hordeum vulgare were exposed to x radiation using the doses 250, 500, 750, 1000, 1250, and 1500 R in six different cycles for different periods of time. The radiosensitivity coefficients for germination, growth rate in height, and root length and for dry weight of seedlings were determined using the formula $S = e^{-KD}$. The frequency of anaphase abnormality was influenced by the dose and by the number of cycles of irradiation. The values of radiosensitivity coefficients in most cases were higher in Hordeum vulgare compared to that in Lathyrus sativus and such high sensitivity has been ascribed to greater length of chromosome. (auth)

9836 GENETIC RECOMBINATION IN COPRINUS. III. INFLUENCE OF GAMMA IRRADIATION AND TEMPERATURE TREATMENTS ON MEIOTIC RECOMBINATION. Raju, N. B.; Lu, B. C. (Univ. of Guelph, Ont.). Mutat. Res.; 17: No. 1, 37-48(Jan 1973).

Non-lethal doses of gamma irradiation (5 krad) increased meiotic recombination in Coprinus lagopus when treatments were given at the beginning of karyogamy. The division stage at this time was judged to be late leptotene and the duration of the sensitive period was assessed to be 3 to 4 hr. In C. lagopus the radiation-sensitive stage is distinct from the cold-sensitive stage (pachytene). The additive effect of irradiation at early karyogamy followed by cold treatment in pachytene suggested that the two factors influenced different steps in the recombination process. On the other hand, irradiation followed by heat treatment did not significantly alter recombination frequency as compared to single treatments. It was surmised that radiation and high temperature act on the same factor(s) or at the same steps to bring about a similar net result. It was suggested that irradiation at leptotene may cause single-strand breaks in DNA that eventually participate in exchange. (auth)

9837 CROSS SENSITIVITY TO RADIATIONS, CHEMICAL MUTAGENS, AND HEAT TREATMENT OF X-RAY SENSITIVE MUTANTS OF YEAST. Evans, W. E.; Parry, J. M. (University Coll., Swansea, Eng.). Mol. Gen. Genet.; 118: No. 3, 261-71 (1972).

A number of radiation sensitive mutants of yeast were examined for their sensitivity to the inactivating agents, ultraviolet light (uv), gamma irradiation, ethyl methane sulphonate (EMS), and heat treatment (52 and 37°). A mutant of the gene rad-3, isolated on the basis of its primary sensitivity to uv showed sensitivity only to uv. In contrast the five x-ray sensitive mutants were sensitive to all four inactivating treatments. Considerable variation was observed in the response of the mutants to liquid holding treatment in non-nutrient solution. The data concerning the heat sensitivity of the x-ray sensitive mutants confirms the correlation between heat and x-ray sensitivity observed in bacteria by Bridges (1969). The results indicate that at least two separable pathways of cellular repair exist in yeast, one effective in the repair of uv damage and the other effective in the repair of ionizing radiation, alkylating agents, heat and a fraction of uv damage. (auth)

9838 CELL CYCLES IN A COMPLEX MERISTEM AFTER X-IRRADIATION. Clowes, F. A. L. (Oxford Univ.). New Phytol.; 71: No. 5, 891-7(Sep 1972).

Mean rates of mitosis, determined over short intervals of time by blocking the cell cycle at metaphase, fall immediately after x irradiation in most parts of the root meristem of Zea mays. The fall continues for several hours and is then replaced by a rise until normal rates are reached. In the quiescent center, however, the mean mitotic cycle shortens to one-third of its previous duration within an hour of irradiation. The rate of mitosis then falls to nearly its previous level before rising again at the same time as the acceleration of the cycle in the other regions. Finally, quiescence sets in again as the other regions return to greater mitotic activity. The observations suggest that the reaction of the quiescent center is not simply due to the relief of some inhibition imposed by the surrounding cells, that something other than the different DNA levels of the various regions is in part responsible for the differential response, and the resistance of the quiescent center to irradiation is a real phenomenon requiring explanation. (auth)

Radiation Effects on Animals

Refer also to abstract 9552.

Man

Refer also to abstracts 9439, 9526, 9559, 9560, and 11174.

9839 (AEC-tr-7387, pp 65-163) NONTUMOROUS FORMS OF REMOTE AFTEREFFECTS CAUSED BY EXPOSURE TO EXTERNAL RADIATION SOURCES. Translated from pp 62-148 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

ANIMALS—radiation effects on, during chronic exposure, development of delayed
GAMMA RADIATION—effects on bone fracture and wound healing in dogs and guinea pigs following combined external and internal exposure, delayed
HEMATOPOIESIS—radiation effects on bone marrow, in rats following repeated acute exposures, delayed
—radiation effects on, in dogs for years following mixed gamma-neutron exposure, γ and neutron
IMMUNE REACTIONS—radiation effects on, of dogs, delayed γ and neutron

KIDNEYS—radiation injuries in dog, following internal exposure, development of delayed
LIFE SPANS—radioinduced shortening of, in rats following daily exposure, role of radiation sickness in γ
MAN—radiation effects on, during chronic exposure, development of delayed
—radiation effects on electrolyte balance in, clinical importance of delayed
RABBITS—radiation effects on cardiovascular system in, during chronic exposure, delayed γ
—radiation effects on osteogenesis in, following chronic low dose exposure, delayed γ
RADIATION—effects on man following therapy, development of delayed pathological
RADIATION SYNDROME—clinical characteristics of chronic, in man during recovery period (E.R.B.)

9840 (BNWL-SA-4382). PHYSICAL CHARACTERISTICS OF PARTICLE BEAMS. Roesch, W. C. (Battelle Pacific Northwest Labs., Richland, Wash.). 15 Sep 1972. Contract AT(45-1)-1830. 29p. (CONF-721045-1). Dep. NTIS.

From Conference on particle accelerators in radiation therapy; Los Alamos, NM (2 Oct 1972).

The use of heavy charged particles (mesons, protons, alpha particles, and ions of even heavier atoms) for radiotherapy appears promising for at least two reasons: heavy particles have depth-dose distributions that should be more advantageous than those of conventional radiations, and heavy particles have high LET (linear energy transfer) along at least part of their paths and thus may benefit from the oxygen effect. The physical characteristics of particle beams that are relevant to exploiting these two properties are reviewed. (auth)

9841 (ORP-SID-72-1) NATURAL RADIATION EXPOSURE IN THE UNITED STATES. Oakley, D. T. (Office of Radiation Programs, Washington, D. C. Surveillance and Inspection Div.). Jun 1972. 75p.

Thesis. Submitted to Harvard School of Public Health, Boston.

The exposure of man to natural radiation sources in the United States has been estimated by considering the distribution of the population with respect to certain factors, principally geology and elevation, which influence exposure to terrestrial and cosmic radiation. Data obtained by aerial surveys in the United States have been used to calculate an average dose equivalent (DE) estimate of 40 mrem/yr to the population. The results also indicate three distinct areas of terrestrial radioactivity in the United States: the Coastal Plain, which consists of all or portions of states from Texas to New Jersey (23 mrem/yr); a portion of the Colorado Front Range (90 mrem/yr); and the rest of the United States, (46 mrem/yr). Since elevation is the primary determinant of cosmic ray DE in the United States, the population distribution with respect to elevation was determined. The average population elevation of the United States was determined to be approximately 700 feet, and the average cosmic ray DE was estimated to be 44 mrem/yr. To arrive at an estimate of the gonadal DE, the influence of housing, biological shielding, and the DE contribution from internal emitters was also considered. The first two factors serve to attenuate man's gonadal DE due to terrestrial radiation by about the same amount that is contributed by internal emitters. The average gonadal DE to the U. S. population was calculated to be 88 mrem/yr. (auth)

9842 ALTERATIONS IN HEINZ BODIES AND RETICULOCYTES OF MEDICAL PERSONNEL AS BIOLOGICAL DOSIMETERS. Carpaij, W. J. M. (Reactor Centrum Nederland, Petten). J. Belge Radiol.; 55: No. 4, 467-80(1972). (In Dutch).

After a description of the concept of a biological dosimetry, the author gives the requirements to be fulfilled by these indicators. In the medical controls at the RNC, much importance is given to alterations of the red blood cells, more specially to the number of reticulocytes and the inclusion bodies (Heinz bodies). It is shown that the number of reticulocytes increases in radiological workers in proportion with the received dose. The same can be said about the Heinz bodies. (auth)

9843 USE OF CHROMOSOMAL ABERRATIONS AS BIOLOGICAL DOSIMETERS FOR ESTIMATING RADIATION DOSE IN MAN. Le Go, R. (CEN, Fontenay-aux-Roses, France). J. Belge Radiol.; 55: No. 4, 481-91(1972). (In French).

The quantitative estimation of an acute human irradiation, written in terms of "single homogeneous total dose" is possible on the basis of a chromosomal analysis. The score is based on counting the dicentrics, the rings, and fragments in a lymphocytes culture of 48 hrs. The reference curves must be established by the same laboratory and with the same laboratory and with the same techniques as for the dosimetric estimation. The curves refer to a definite type of radiation (pure gamma, gamma + neutron) and to a definite energy spectrum. In these conditions, the dosimetric values obtained are reliable and their sensitivity extends to about 10 Rems. (auth)

9844 BIOCHEMICAL INDICATORS OF RADIATION DAMAGE: PERSPECTIVE AND REVIEW. Gerber, G. B. (CEN/SCK, Mol, Belgium). J. Belge Radiol.; 55: No. 4, 493-501(1972).

Biochemical indicators represent an attempt to assess radiation damage on the basis of metabolic changes in the irradiated organism. While biochemical reactions are less sensitive and less specific for the radiation insult than hematological and cytogenetic ones, they have the advantage to respond early and in most cases, to be easily performed. Nevertheless, biochemical indicators have lagged somewhat in their development since due to differences between species, no such test can be of use unless tested in man. The following potential indicators are discussed in more detail. Urinary excretion of deoxycytidine, of pseudouridine, of taurine, of creatine, of amino acids, and of hydroxyindolacetic acid, as well as concentration in the serum of proteins and enzymes. (auth)

9845 COBALT TELERADIOTHERAPY OF LARYNGEAL CANCER. PRELIMINARY EVALUATION OF RESULTS. Wasilewski, Michal; Nowak, Gizela (Inst. of Oncology, Warsaw). Nowotwory; 22: No. 3, 219-24(1972). (In Polish).

The results of teleradiotherapy with ^{60}Co γ in 83 cases of laryngeal cancer are reviewed. Three-year survival rate was 57% (47 cases) including all cases with grade I and II cancer, and 36 cases with grade III cancer (52%). In a group of 6 patients followed for five years, 46% of cures were obtained. The results were analysed in relation to the grade of clinical progression, frequency of failures, local complications, and the tumour dose. It was concluded that ^{60}Co teleradiotherapy in cases with cancer grade I and II is the method of choice. In the group of patients with grade III, a considerable cure rate was also obtained. Tumour doses exceeding 7500 R are not associated with a greater percentage of local cures but the risk of radiation-induced complications is raised markedly. (auth)

9846 RADIATION-INDUCED SARCOMATOUS DEGENERATION OF THE LOWER ABDOMINAL WALL: REPORT OF A CASE. Skinner, D. G. (Univ. of California, Los Angeles). J. Urol.; 108: No. 6, 879-81(Dec 1972).

Radiation-induced fibrosarcoma developed in the lower abdominal wall of a patient 4½ yrs after he had undergone ancillary radiation therapy for bladder carcinoma. Excision was successful and closure was accomplished using the scrotal skin transfer technique. With increased use of radiation as both primary and ancillary therapeutic modalities, long-term neoplastic complications may be anticipated. Aggressive surgical efforts may afford cure, or at least palliation, provided that there is early recognition and wide excision is accomplished. (auth)

9847 RETROPUBIC IMPLANTATION OF ^{125}I IN THE TREATMENT OF PROSTATIC CANCER. Whitmore, W. F. Jr.; Hilaris, Basil; Grabstald, Harry (Memorial Hospital, New York). J. Urol.; 108: No. 6, 918-20(Dec 1972).

A technique of retropubic implantation of ^{125}I seeds in selected patients with prostatic cancer is presented. The method is technically simple and it has permitted delivery of potentially effective irradiation to the prostate, constituted a 1-step treatment, required a relatively short hospitalization, had no associated mortality and only minimal morbidity, produced only minimal disturbances in urinary, rectal, and sexual functions, resulted in more accurate tumor staging, and produced an encouraging degree of local regression in clinically evident prostatic lesions during a brief period of followup. (auth)

9848 COMPLICATIONS AND REGRESSION OF PRIMARY TUMOR SIZE WITH RADIOTHERAPY IN PROSTATIC CANCER. Phillips, N. B.; Lattimer, J. K. (Columbia-Presbyterian Medical Center, New York). J. Urol.; 108: No. 6, 921-3(Dec 1972).

Early complications of radiotherapy occurred during treatment of cancer of the prostate gland. Forty percent of patients experienced mild diarrhea, 33% had dysuria, and 24% had urinary frequency. Only 15% of patients did not respond to medication and, in almost half of these, dysuria persisted for at least 2 yrs after therapy. There was 1 case of severe radiation cystitis. Of 12 patients studied for regression rate of the primary tumor, only 1 showed regression at the termination of treatment. After 1 to 2 months, 75% of the tumors had decreased in size and/or hardness and at 4 months all showed signs of local regression. (auth)

9849 IRRADIATION TREATMENT OF CARCINOMA OF THE PROSTATE: A PRELIMINARY REPORT BASED ON 8 YEARS OF EXPERIENCE. Carlton, C. E. Jr.; Dawoud, Fouad; Hudgins, Philip; Scott, Russell Jr. (Baylor Coll., Houston, TX). J. Urol.; 108: No. 6, 924-7(Dec 1972).

We have submitted 106 patients with stages A, B, and localized C carcinoma of the prostate to irradiation therapy in an attempt

to cure their disease. The morbidity of treatment is low. To properly stage patients to be treated in this manner, retropubic exploration and pelvic node biopsy are recommended. Biopsy prior to 6 months after irradiation may be misleading. However, followup without biopsy of patients whose prostate feels normal on rectal examination may be misleading since 5 of 12 patients who were biopsied were found to have residual tumor even with a normal consistency to the gland. External irradiation has been found to be effective as a palliative measure in relieving bladder neck obstruction, invasion of the ureter with hydronephrosis and troublesome hemorrhage from the prostate. When confronted with a disease that is known to have variable growth rates, one must be cautious in arriving at conclusions based on small numbers of patients for a relatively short period of time. A minimum of 10 and preferably 15-yr followup will be required. However, we have been treating patients for more than 8 yrs with radiotherapy and our results continue to support our enthusiasm for this modality of therapy for cure or local control. More cases need to be treated and followed for a much longer period of time before final conclusions can be reached. (auth)

Vertebrates

Refer also to abstracts 9265, 9814, and 9824.

9850 (AD-857542) CELL PROLIFERATION AFTER IRRADIATION. Technical Report, November 1966–June 1968. Wailly, L. F. (Colorado State Univ., Fort Collins). Jul 1969. Contract F29601-67-C-0019. 192p. (AFWL-TR-69-43). NTIS.

Both biological and physical aspects of radiation dosimetry were considered in this study. The biological dosimetry involved specific patterns of hemopoiesis following irradiation, especially erythropoiesis. Three groups of animals were used for this experiment. Group I, the control group, received no irradiation and each animal was given 13.2 microcuries/kg of glycine-2-^{14}C intravenously. Group II received the same amount of ^{14}C glycine as the control group immediately following irradiation from a ^{60}Co source. Group III was injected with the labeled glycine on the fourth day following exposure to the ^{60}Co source. Identical exposures were experienced by Groups II and III (50 R, 100 R, 200 R, 600 R, and 800 R). Exposure rates of 53 R/min were made at a point corresponding to the mid-line of the animal. With damage to the stem cell compartment, the red cell renewal system will give a cell population which will be an indicator of residual injury. This injury was shown to be dose dependent. Part two of this study illustrates the energy dependence of depth dose patterns to gamma or x-rays. A detailed study is presented comparing the efficiency of a solid state thermoluminescent dosimetry system to that of a previously proven tissue equivalent ionization chamber. (auth)

9851 (AEC-tr-7387) REMOTE AFTEREFFECTS OF RADIATION DAMAGE. Moskalev, Yu. I. (ed.). Translation of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971. 574p. Dep. NTIS.

Separate abstracts were prepared for the six chapters in this publication. (E.R.B.)

For abstracts of individual chapters see: 9839, 9852–9855, and 9881.

9852 (AEC-tr-7387, pp 5-64) GENERAL ASPECTS OF THE REMOTE AFTEREFFECTS OF RADIATION DAMAGE AND MEANS FOR STUDYING THEM. Translated from pp 10-61 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

The nontumorous and tumorous remote aftereffects of radiation damage are discussed. Four papers are presented in which the following related topics are discussed: status and prospects of investigation of remote aftereffects; molecular nature of remote aftereffects and ways to prevent and treat them; cell cultures as a model for studying remote after effects; and morphological study of a mouse fibroblast culture following γ irradiation. (E.R.B.)

9853 (AEC-tr-7387, pp 164-213) BLASTOMOGENTIC EFFECT OF EXTERNAL RADIATION SOURCES. Translated from pp 149-96 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

CATARACTS—radioinduced, in rats, effects of dose on incidence of delayed β

NEOPLASMS—tumors, incidence of spontaneous, in dogs
—tumors, incidence of spontaneous skeletal, in dogs
—tumors, radioinduced, in dogs following internal administration of polonium-210 or external mixed gamma-neutron exposure, incidence of delayed
—leukemia, radioinduced acute, in guinea pigs during chronic low dose rate exposure, delayed γ
—tumors, radioinduced, in dogs following whole-body mixed gamma-neutron exposure, time dependence of delayed
—tumors, radioinduced endocrinal, in female dogs, effects on reproductive capacity, delayed mixed gamma-neutron
—tumors, radioinduced, in rats following single or repeated exposures, comparison of frequency of γ, proton, and x
—tumors, radioinduced mammary gland and skin, in rats, effects of dose on incidence of delayed β (E.R.B.)

9854 (AEC-tr-7387, pp 512-38) REMOTE AFTEREFFECTS FROM COMBINED EXPOSURE TO RADIATIVE AND NONRADIATIVE FACTORS. Translated from pp 465-89 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

GAMMA RADIATION—effects on offspring of rats subjected to whole-body exposure, combined effects of inhaled mercury on

STRONTIUM-90—effects on rats following chronic administration, combined effects of chemical carcinogens on delayed tumorigenic

THORIUM ISOTOPES—effects on offspring of rats following intraperitoneal injection of dam, combined effects of injected metals on delayed pathological

X RADIATION—effects on rats following whole-body exposure, combined effects of chronic ingestion of cerium-144 and strontium-90 on delayed pathological (E.R.B.)

9855 (AEC-tr-7387, pp 539-74) PROBLEMS IN PREVENTING REMOTE AFTEREFFECTS. Translated from pp 490-524 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

AMERICIUM-241—effects on rat liver following intravenous injection as chloride, effects of dose on frequency and rate of development of delayed pathological

GAMMA RADIATION—effects on rats, protective effects of cystamine and serotonin against delayed pathological and tumorigenic

PROTONS—effects on mice following whole-body exposure, effects of radiation dose on protective effects of mexamine against delayed pathological

STRONTIUM-90—effects on rats following intraperitoneal injection, combined effects of administration of Bacillus vaccine on delayed pathological and tumorigenic

X RADIATION—effects on incidence of mammary tumors, life span, and physiological parameters of rats following low dose exposure, effects of dose on (E.R.B.)

9856 RBE FOR HIGH-LET RADIATIONS WITH RESPECT TO MUTAGENESIS. A Report Prepared by a Task Group of Committee 1 of the International Commission on Radiological Protection. New York; Pergamon Press (1972). 49p. (ICRP-18).

The subject of radioinduced mutagenesis is dealt with in several sections. Topics discussed include present and potential human exposures to high-LET radiation (cosmic radiation, artificial sources); types and characteristics of the high-LET radiations used in mutagenesis research (types of radiation, radiation quality, LET, LET distributions, average LET); studies on mutation induction (micro-organisms, fungi, higher plants, insects, experimental mammals, man); interpretation of the results; relationship between LET and RBE for mutation induction; factors likely to influence the RBE-LET relationship (dose and dose rate, dose fractionation, sex and type of germ cell, oxygen, type of mutation); applicability to man; and implications for radiation protection. (200 references.) (UK)

9857 MUTAGENIC EFFECT OF REPEATED SMALL RADIATION DOSES TO MOUSE SPERMATOGONIA. III. DOES REPEATED IRRADIATION REDUCE TRANSLOCATION YIELD FROM A LARGE RADIATION DOSE. Lyon, M. F.; Phillips, R. J. S.; Glenister, P. H. (Medical Research Council, Harwell, Eng.). Mutat. Res.; 17: No. 1, 81-5(Jan 1973).

Previous results had suggested that daily repeated doses of 10 rad x- or γ rays to mouse spermatogonia decreased their sensitivity to translocation yield. This was tested by comparing the effects of a dose of 300 rad γ rays given before, 24 hr after, or 8 days after, 30 daily doses of 10 rad γ rays to male mice. The yield of translocations per cell from those receiving the 300 rad dose 24 hr after the repeated ones (7.3%) was significantly lower than that from the other two regimes (9.4 and 9.7% respectively). This was consistent with the explanation that the repeated irradiation had temporarily increased the resistance of the spermatogonial cell population to translocation yield. However, there must remain some doubt about this interpretation since the absolute values of translocations found were too high, and the yield from those that had received the 300-rad dose 24 hr after the repeated ones was not significantly below the sum of those from a single dose and from repeated doses given separately. (auth)

9858 RADIATION-INDUCED CHROMATID ABERRATIONS IN THE BONE MARROW AND LYMPH NODES OF THE RAT DUR-

ING THE FIRST 24 HR AFTER IRRADIATION. Sempinska, E. (Inst. of Occupational Medicine, Lodz, Poland). Mutat. Res.; 17: No. 1, 12..-6(Jan 1973).

Wistar rats of both sexes were exposed to 100 R of x rays. Chromatid-type aberrations in metaphase figures of bone marrow and lymph node cells were scored after 2, 4, 6, 8, and 24 hr and 3, 5, 7, 9, and 24 hr, respectively. The shape of the curve for chromatid plus isochromatid breaks in bone marrow cells versus time is exponential. It is suggested that this shape is mainly a consequence of the continuous entrance into mitosis of cells irradiated while in S phase, in addition to those that were irradiated in G_2. For lymph nodes, the frequency of chromatid plus isochromatid deletions increased up to the 5th hr, then began to fall off in a manner similar to that for the bone marrow. The difference in the shape of the two curves is the consequence of the different dependence on time for chromatid and isochromatid breaks in each tissue. While the frequency of chromatid breaks fell steeply with time both for the bone marrow and for lymph nodes, the frequency of isochromatid breaks remained nearly constant for bone marrow, whereas it rose to a peak at the 5th hr for the lymph nodes. These differences are tentatively explained by a shift in the phases of the cell cycle sampled owing to the greater mitotic delay of G_2 cells in lymph nodes, with the suggestion that in the late S phase the frequency of isochromatid breaks is lower than in all other phases of the cell cycle. (auth)

9859 EVOLUTION OF SUPRAOPTICAL AND PARAVENTRICULAR NUCLEI (SON AND PVN) AFTER X IRRADIATION AND SUBSEQUENT THIAMINE TREATMENT IN WHITE RATS. Miscalencu, D. (Univ., Bucharest); Zaharia, F. Radiobiol.-Radiother.; 13: No. 5, 593-8(1972).

Seven days after total irradiation with 800 R, the cells of the SON and PVN neurosecretory nuclei of white rats are strongly deprived of neurosecretory material, presenting clear, vacuolar spaces. The thirty-first day after irradiation, the cytological map of SON and PVN shows an intensive elaborating activity of the cells of these nuclei, the depositing of the neurosecreted material being visible in many SON cells and in all the PVN ones. The action of the lethal x rays allows the resuming of the functions of the hypothalamic neurosecretory cells. In irradiated animals treated with thiamine, the elaborating activity of SON and PVN cells is hampered, thus diminishing the capacity of accumulation of neurosecretory material. (auth)

9860 PECULIARITIES OF RADIATION INJURY OF CELLS OF THE OUTER GRANULAR LAYER OF THE DEVELOPING SMALL BRAIN OF THE RAT. Gulyaev, V. A.; Korogodina, Yu. V.; Dubrovina, V. M. (Inst. of Medical Radiology, Obninsk, USSR). Radiobiol.-Radiother.; 13: No. 5, 565-80(1972). (In German).

Sections of the developing small brain of the rat that were obtained at different times after a whole-body gamma-ray irradiation were microscopically and electron microscopically examined. The 5 day old animals were irradiated with a dose of 600 R which is necessary and sufficient for the maximum death of the cells of the outer body layer (about 90%). The destruction of the cells occurs up to their entrance into the first mitosis after irradiation according to the kind of interphase death. Obvious injuries of the ultrastructure of the cells appear 2 hrs after irradiation at the same time the beginning of a pyknotic degeneration being observed by microscope. The number of damaged cells that is registered on the electron microscopic photographs does not exceed the number of dead cells that can usually be found by means of the number of pyknoses. Therefore the authors tend to consider the mentioned ultrastructural changes—enlargement of mitochondria, destruction of their membrane, decomposition of the endoplasmatic reticulum and of the nuclear membrane—to be irreversible and to think them to be morphological manifestations of necrosis. A considerable part of the surviving cells is capable of phagocytosis which plays an important part in the elimination of dead cells. (auth)

9861 EXAMINATIONS FOR THE IMPROVEMENT OF BLOOD CIRCULATION OF FULL-SKIN GRAFTS IN RADIATION INJURED TISSUE BY A TEMPORARY BIOLOGICAL WOUND-BANDAGE. Roggendorf, E.; Moepert, S.; Vollmar, R.; Moepert, M. Humboldt Univ., Berlin). Radiobiol.-Radiother.; 13: No. 5, 581-6(1972). (In German).

Experiments of skin grafting on rats are reported. Radiation injured scarred skin was excised, the defect was first of all provided with a lyophilizated and autologous, respectively, pregraft and later on it was covered by an autologous full-skin graft. The pretreatment of the transplant store with a lyophilizated pregraft yielded a better blood circulation during the first 6 days after the grafting compared with a control graft without pregraft. As the measuring method, the determination of the pulse rate height was chosen. The radionuclide ^{35}S was used as a beta-ray emitter. The advantages of ^{35}S for such an experimental assembly are briefly reported. (auth)

9862 ABLATION OF SENSITIZATION TO BONE MARROW ALLOGRAFTS. Riches, A. C.; Thomas, D. B. (Medical School, Birmingham, Eng.). Proc. Soc. Exp. Biol. Med.; 141: No. 2, 731-4(Nov 1972).

Mice which have been immunized against the isoantigens of allogenic bone marrow cells reject bone marrow cells from donors of the allogeneic strain that are injected after the administration of a lethal dose of whole-body x irradiation. Repopulation of the damaged hematopoietic tissues is therefore prevented. It has now been demonstrated that treatment with anti-lymphocyte serum or normal rabbit serum abrogates such immunity, as allogeneic bone marrow cells repopulate the medullary cavity of the femur in sensitized recipients treated with antilymphocyte serum or normal rabbit serum before being exposed to a lethal dose of whole-body x irradiation. (auth)

9863 SECONDARY DISEASE IN MICE AFTER IN VITRO EXPOSURE OF HEMATOPOIETIC CELLS TO CONCANAVALIN A. Ledney, G. D. (Univ. of Tennessee, Memphis). Transplantation; 14: No. 6, 671-82(Dec 1972).

Injection of spleen cells following incubation with concanavalin A (Con A), a plant agglutinin, resulted in survival of lethally irradiated allogeneic mice and death of lethally irradiated syngeneic mice. When irradiated mice were allogeneic with respect to the graft, suppression of the 100% lethal secondary disease reaction was observed. A survival of 60% and freedom from secondary disease in some mice was associated with a concentration of 100 or 1,000 μg/ml of Con A and a concentration of $10 - 20 \times 10^6$/ml of cells. Wasting or diarrhea was seen in 40% of all irradiated mice living more than 30 days which were previously grafted with syngeneic spleen cells incubated with Con A. The nature of these observations is unclear, as the morphological and histological findings were not consistent with those of classical secondary disease. Irradiated mice grafted with allogeneic spleen cells incubated with Con A were chimeric, while survival was not associated with hematopoietic restoration induced by Con A alone. Con A was superior to phytohemagglutinin-P (PHA-P) in the suppression of secondary disease by in vitro exposure with immune competent cells. Incubation of hematopoietic cells with Con A consistently resulted in their agglutination. Con A was not toxic to suspensions of hematopoietic cells but was toxic to mice when injected i.v. alone or complexed to cells at levels of 1,000 μg/ml or more. Incubation of marrow cells with Con A resulted in a decreased number of splenic nodules. (auth)

9864 COMPARATIVE LITTER AND REPRODUCTION CHARACTERISTICS OF MOUSE POPULATIONS WITH X-RAY EXPOSURE, INCLUDING 45 GENERATIONS OF MALE PROGENITORS. Spalding, J. F.; Brooks, M. R. (Los Alamos Scientific Lab., NM). Proc. Soc. Exp. Biol. Med.; 141: No. 2, 445-7(Nov 1972).

Observations were made of comparative litter and reproduction characteristics of two H-2 genotype substrains of mice within each of two lines. Two substrains ($H\text{-}2^f$ and $H\text{-}2^b$) were from 45 generations of x-irradiated male progenitors, and two were from F_{45} nonirradiated progenitors. No cumulative radiation-induced genetic decrement was noted in irradiated line mice of either H-2 substrains. A comparison of F_6 with F_{46} data showed no degradation in reproductive fitness during 40 generations of x-ray exposure. The F_{46} data suggest that a single gene effect on weaning weights may exist. (auth)

9865 EFFECTS OF SINGLE THORACIC X-RAY EXPOSURE IN RATS. Kurohara, S. S.; Casarett, G. W. (Univ. of Rochester, NY). Radiat. Res.; 52: No. 2, 263-90(Nov 1972).

Pathophysiologic changes in female and male rats after exposures to single doses of thoracic x irradiation of 0, 600, 1200, 2400, or 3600 rad, are reported and discussed. The dose of 3600 rad caused death associated with a starvation-like effect during 1 to 4 weeks postexposure period, attributable largely to severe esophageal damage. The dose of 2400 rad permitted longer survival than that at 3600 rad and death was associated chiefly with lung fibrosis. The mortality of rats after doses in the range of 1200 or 600 rad roughly paralleled that of the control group and showed no special modal death times or special causes of death. Differences in responses between sexes were slight. (auth)

9866 RESPONSE OF HEMOPOIETIC COLONY-FORMING UNITS TO REPEATED DOSES OF X-RAYS. Hendry, J. H.; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Radiat. Res.; 52: No. 2, 309-15(Nov 1972).

The response of bone marrow stem cells to repeated large doses of x rays was investigated in the mouse using the spleen colony assay technique. Four repeated doses of 450 rad, separated by 24 days, produced residual injury in the system charac-

terized by a reduction in the stem cell compartment size, and a difference in the recovery patterns after the last dose compared to the first. The reduced recovery rates are shown to be due to damage to the milieu rather than damage to the cells themselves. (auth)

9867 ACUTE RADIATION EFFECTS IN KIDNEY. Hampton, J. C. (Battelle-Northwest, Richland, WA). Radiat. Res.; 52: No. 2, 316-23(Nov 1972).

Mice were exposed to 1500 R of x radiation and injected with horseradish peroxidase 2 min prior to sacrifice on days 1, 2, 3, 3.5, and 4 postexposure. Kidney damage in the form of increased tubular permeability to peroxidase was detected as early as day 1, suggesting that functional damage occurred before morphologic lesions became apparent. Changes were observed in glomeruli on day 2, mainly involving capillary endothelium and some focal thickening of the basement membrane. (auth)

9868 ANTIGENICITY OF RADIOSTRONTIUM-INDUCED OSTEOSARCOMAS. Nilsson, A. (Research Inst. of National Defense, Sundbyberg, Sweden); Revesz, L.; Eriksson, K. H. Radiat. Res.; 52: No. 2, 395-408(Nov 1972).

Osteosarcomas that arose in CBA mice following the administration of 0.7 μCi ^{90}Sr/g body wt were tested for the ability to induce resistance to their own transplantation in recipient mice, syngeneic with the strain of origin. The recipients were pretreated by repeated injections of heavily irradiated cells derived from the tumors and/or were preirradiated on the whole body with 400 R. Controls included untreated recipients and recipients pretreated with heavily irradiated cells from normal, syngeneic tissues. Graded doses of viable tumor cells between 5×10 and 10^5 were used for the transplantation challenge. A total of 23 different osteosarcomas were tested in corresponding groups, the total number of challenge amounting to 1637. The incidence of progressively growing tumors was registered for a period of 8 to 12 months after transplantation. Insignificant differences in the tumor incidence were found between the groups pretreated with irradiated neoplastic or normal tissues and the untreated controls. In the whole body-irradiated mice the incidence was significantly greater than in the unirradiated ones. Treatment with heavily irradiated tumor cells prior to whole-body irradiation decreased the frequency of progressively growing tumors in comparison to treatment with heavily irradiated normal tissues. In all preirradiated groups, osteosarcomas with fibroblastic character developed in somewhat greater frequency than osteosarcomas with osteoblastic character. The data were interpreted as indicating that radiostrontium-induced osteosarcomas possess specific transplantation antigens. The degree of the antigenicity of the tumors may be related to their histologic type. (auth)

9869 EARLY EFFECTS OF X-RAYS UPON SOME MECHANICAL PROPERTIES OF RAT FEMURS. Miller, A. L. Evanston, IL; Northwestern Univ. (1972). 341p. University Microfilms Order No. 72-32,517.

Thesis.

The effects of age at the time of exposure and level of x-ray dose (0 to 5600 rads) upon some mechanical properties of bones on young rats and mature rats were studied. At approximately monthly intervals, four animals from each treatment level were sacrificed and their femurs excised. Measurements were made of weight, length, cortical bone thicknesses, and maximum breaking load. From these data, breaking stress and modulus of elasticity were computed. The effects of animal age, radiation dose to the femur, and time post-exposure on these measured quantities were determined using multivariate analyses of variance, multiregression analyses, linear regression analyses, and "Student's t" tests. The primary conclusions that can be drawn from this research are: The effects of radiation on the young animals increased with increasing dose. At each dose there appears to be a linear relationship between the measured effect (length, weight, breaking load) and the time post-exposure. Essentially, no changes were detected in the quantities measured for the femurs in the mature rats. The quality of bone present after irradiation appears to remain unchanged. However, either the mass of bone, or the distribution of the mass, or both are affected by the radiation dose and/or time post-exposure in the young animals, indicating that radiation damage may be primarily to growth centers and not to the mineral phase, or cortical bone. No significant change was found in the breaking stress or the modulus of elasticity in either age group of animals. (Diss. Abstr. Int., B)

9870 CHROMOSOME ABERRATIONS IN THE LIVER OF THE CHINESE HAMSTER FOLLOWING EITHER ACUTE OR FRACTIONATED ^{60}Co-IRRADIATION. McKay, L. R. Lafayette, IN; Purdue Univ. (1972). 98p. University Microfilms Order No. 72-30,937.

Thesis.

A study was conducted to determine the repair rate of chromosome aberrations in Chinese hamster liver up to 36 weeks following an acute whole-body exposure to ^{60}Co of 400 R. In addition, the relationship between chromosome damage in the liver and cumulative radiation exposure delivered at 4 R or 8 R per day was determined. Six groups of ten Chinese hamsters, with six irradiated and four non-irradiated controls per group, were given an acute whole-body exposure of 400 R from ^{60}Co. A group of irradiated and control animals underwent partial-hepatectomy to stimulate hepatocellular proliferation at 1, 4, 8, 12, 24, or 36 weeks postexposure. The hamsters were sacrificed 54 hrs later and the liver chromosomes analyzed at metaphase. Computer-derived regression equations fit to the chromosome data from animals analyzed from 1 to 36 weeks postexposure were $Y = 0.446 + 9.0 \times 10^{-4}X$ breaks per cell and $Y = 0.275 - 1.1 \times 10^{-3}X$ aberrations per cell. The equations were of the linear form $Y = a + bX$, where Y = chromosome aberration yield, a = ordinate intercept, b = coefficient for chromosome repair with time, and X = time post-exposure in weeks. The low values of b observed indicated minimal or no repair of damaged chromosomes with time. Apparently a liver cell with damaged chromosomes could remain in situ in its original damaged state for up to 36 weeks post-exposure, thereby remaining available for analysis. If no significant chromosome repair were observed with time, a fractionation experiment at low exposures in which chromosome damage could be accumulated would seem justified. Chromosome analysis of cells in which significant repair was occurring would be subject to inherent error, in that a certain portion of damaged chromosomes would be removed through the process of cellular division or through repair. Four groups of ten Chinese hamsters, with six irradiated and four non-irradiated controls per group, were irradiated at an exposure rate of 4 R per day and subjected to partial-hepatectomy and subsequent chromosome analysis at cumulative exposures of 200, 400, 600, and 800 R. Five groups of ten hamsters, with six irradiated and four non-irradiated controls per group, were exposed to ^{60}Co at 8 R per day. At cumulative exposures of 200, 400, 600, 800, and 1,000 R, the animals were subjected to partial-hepatectomy and chromosome analysis. Regression equations best-fit to the chromosome data from cumulative exposures of 200 to 800 R were $Y = 0.012 + 4.36 \times 10^{-4}X$ breaks per cell and $Y = 0.003 + 2.62 \times 10^{-4}X$ aberrations per cell for animals exposed at 4 R per day. The equations for animals exposed to 8 R per day to cumulative exposures of 200 to 1,000 R were $Y = 0.036 + 3.64 \times 10^{-4}X$ breaks per cell and $Y = 0.029 + 2.26 \times 10^{-4}X$ aberrations per cell. The equations were of the linear form $Y = a + bX$, where Y = chromosome aberration yield, a = best-fit background aberration level, b = coefficient for aberration production, and X = cumulative exposure in Roentgens. The coefficient for aberration production, b, was noted to be nearly equal in comparisons between chromosome data from the 4 R and 8 R irradiation series. A subsequent two-way analysis of variance confirmed no significant difference at the 95% confidence level between chromosome damage observed at any cumulative exposure designated in the investigation, whether delivered at 4 R or at 8 R per day. A statistically significant increase in chromosome damage was noted with increasing cumulative exposure. Based on the regression equations, the levels of chromosome damage at a cumulative exposure of 400 R delivered at 4 R and 8 R per day were 0.107 and 0.119 aberrations per cell, respectively, compared to 0.275 aberrations per cell for animals given an acute exposure to ^{60}Co of 400 R. The fractionation and acute data were found to be statistically different by the Student's t test. (Diss. Abstr. Int., B)

9871 CONTENT OF ETHANOLAMINE IN THE LIVER AND BRAIN OF A NORMAL RAT AND IN THE DEVELOPMENT OF ACUTE RADIATION SICKNESS. Movsesyan, M. A.; Ishkhanyan, A. S. (Armenian Inst. of Rentgenology and Oncology, Erevan). Zh. Eksp. Klin. Med.; 11: No. 5, 32-4(1971). (In Russian).

The ethanolamine content was measured in the brain and liver of white rats which had been subjected to 400 R doses of x radiation. Measurements were made on controls, and at the end of 2 hr, 24 hr, and 4, 7, 10, and 15 days after irradiation. The controls contained more ethanolamine in the brain than in the liver. After irradiation a decrease in both areas was noted, the decrease being more pronounced in the liver. (K.S.W.)

9872 EFFECT OF ANOXIA ON THE RESPONSE OF HAEMOPOIETIC COLONY-FORMING UNITS IN DIFFERENT PROLIFERATIVE STATES TO γ RAYS OR D–T NEUTRONS. Hendry, J. H.; Howard, A. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol.; 45: No. 540, 933-7 (Dec 1972).

The spleen colony assay technique was used to measure the oxygen enhancement ratio (OER) for the stem cells in mouse bone marrow, irradiated with γ rays or a collimated 14 MeV neutron beam. The reduction in OER with neutrons compared

with low LET radiation, found in most biological systems studied, was also observed in the present experiments. However, a difference was found between the γ-ray OER for steady-state marrow (1.77 ± 0.12) and that for regenerating marrow (2.51 ± 0.08), which resulted in a larger gain factor for the latter (1.87 ± 0.13) than the former (1.37 ± 0.17). The differences are considered to result from radiation effects on the complex processes involved in the differentiation and proliferation of these cells rather than from differences in oxygen tension. The implications of the results for radiotherapy are discussed. (auth)

9873 RESPONSE OF HAEMOPOIETIC COLONY-FORMING UNITS AND LYMPHOMA CELLS IRRADIATED IN SOFT TISSUE (SPLEEN) OR A BONE CAVITY (FEMUR) WITH SINGLE DOSES OF X RAYS, γ RAYS, OR D–T NEUTRONS. Hendry, J. H. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol.; 45: No. 540, 923-32 (Dec 1972).

A comparison of the effects of single doses of 300 kV x rays, ^{137}Cs γ rays, ^{60}Co γ rays, and 14 MeV D–T neutrons on haemopoietic stem cells and lymphoma cells in the mouse has shown the following: (1) For the cell types used, significantly different RBE (γ/X) values were obtained in soft tissue depending on the nature of the cells and their state of proliferation. (2) The data suggest that stem cell regeneration occurs close to bone surfaces. (3) Cells irradiated in the femur were less sensitive to neutrons (a factor 0.88 ± 0.04 for lymphoma cells) than cells irradiated in the spleen or in suspension. (4) The effect of a first dose of radiation on normal haemopoietic tissue may be different from that of succeeding doses (as during fractionation), depending on the type of radiation and the size of the doses. (5) A comparison of the effects of radiation on the different cell types used in the present experiments has shown that, in general, single doses of fast neutrons are no worse (in damaging normal cells compared with malignant cells) than single doses of conventional low LET radiation. The implications of the findings for radiotherapy are discussed. (auth)

Invertebrates

9874 (BNWL-SA-4435) REVIEW OF EFFECTS OF RADIATION ON AQUATIC POPULATIONS. Templeton, W. L. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. Contract AT(45-1)-1830. 2p. (CONF-721051-1). Dep. NTIS.

From Panel on radiation effects on population dynamics in ecosystems; Reykjavik, Iceland (2 Oct 1972).

Available data on radiation effects on aquatic populations are reviewed. It is pointed out that radiation is not a recent introduction to the marine environment, since low levels from environmental and cosmic sources have been present throughout geological time. Lethal amounts of radiation differ widely among marine organisms and are related to variations such as species, age, physiological status, and body size. These variations are further complicated by the interaction of environmental factors. Exclusive of the eggs of fish and larvae of invertebrates and fish, most marine organisms for which data exist are relatively radioresistant. Limited studies on the effects of chronic exposure have been conducted. These have been limited to selected developmental stages and indicate that, with the possible exception of some Russian data, the dose necessary to evoke an unequivocally detectable biological response is considerably above that of concentrations of radionuclides in the environment as a result of controlled waste disposal operations. Studies on the genetic consequences of radiation exposure to populations indicate that, despite larger numbers of mutations, increased utilization or reproductive capacity maintains a population at preradiation density. Field studies on the effects of radiation indicate that our best technologies and methods cannot demonstrate effects on marine ecosystems, at prevailing dose rates, that are clearly attributable to ionizing radiation. It is concluded that more sensitive parameters of radiation effects on individuals, populations, and communities need to be developed. Long-term studies, in which factors such as rates of growth, morphological abnormalities, onset of maturity, and reproductive capacity are considered, for example, should be emphasized. Chromosomal studies under experimental and field conditions should be extended, and the somatic and genetic consequences of such changes on populations and ecosystems should be evaluated. (C.H.)

9875 (IAEA-R-656-F) STUDIES ON THE EFFECT OF RADIATION ON THE BIOLOGY OF THE PROTOZOAN PARASITE GENUS LEISHMANIA (ROSS 1903) WITH SPECIAL EMPHASIS ON ATTENUATING THE ORGANISMS FOR USE AS VACCINES. Final Report for the Period 1 August 1968–31 March 1971. Lemma, Aklilu (International Atomic Energy Agency, Vienna (Austria)). May 1971. 8p. INIS.

The organism studied was Leishmania enriettii and the host animal was the guinea pig. Growth conditions and requirements of the parasite were studied both in vivo and in vitro. The normal course of infection was found to be 5–6 weeks resulting in either death of the host or the development of active immunity. It was demonstrated that passive immunity from mother to offspring does not occur. X-ray, uv- and γ-irradiation were utilized to study the effect of radiation on the organism. In all cases increasing dosages caused inability of the organisms to go through normal differentiation in vitro, but did not necessarily cause concurrent loss of infectivity. The administration of an "immunizing dose" of a non-infective species, Leishmania tropica, did not result in immunity to Leishmania enriettii. A positive skin test utilizing phenol-killed parasites was correlated with the development of immunity. (auth)

9876 CONSTANT OXYGEN ENHANCEMENT RATIO DURING THE MITOTIC CELL CYCLE IN X-RAYED DROSOPHILA MELANOGASTER EMBRYOS. Wuergler, F. E.; Ulrich, H.; Matter, B. E. (Swiss Federal Inst. of Tech., Zurich). Experientia; 28: No. 9, 1109-11 (15 Sep 1972).

Egg samples were treated with 800 R of 50 keV x radiation; one group was irradiated in air and another in nitrogen. A table is presented to show numbers and percentages of eggs killed following irradiation at embryonic ages of 9.5 to 24.5 min. Graphs are presented to show radiosensitivity of various mitotic stages exposed in air and in nitrogen. Results showed that irradiation in air was about twice as effective as in nitrogen. (H.L.W.)

9877 DEVELOPMENT OF RADIORESISTANCE IN IRRADIATED DROSOPHILA NEBULOSA POPULATIONS. Marques, E. K. (Univ. Federal do Rio Grande do Sul, Porto Alegre, Brazil). Mutat. Res.; 17: No. 1, 59-72 (Jan 1973).

The adaptive value of experimental populations of Drosophila nebulosa, irradiated each generation with doses of 500, 1000, and 2000 R of ^{60}Co gamma rays, was measured with respect to their ability to compete with non-irradiated Drosophila willistoni. Two groups of experiments were developed: (a) to investigate the effects of repeated irradiation in each generation on D. nebulosa under interspecific competition; (b) to demonstrate the radioresistance of D. nebulosa populations with different histories of irradiation. The results obtained through the interspecific competition were confirmed by tests of egg-laying capacity, hatchability, and productivity of D. nebulosa from the competing populations. The populations with previous histories of gamma irradiation were shown to be less susceptible than control populations to the detrimental effects of a new exposure to irradiation. This suggests that radioresistance developed in the D. nebulosa populations that were irradiated over several generations. (auth)

9878 COMPARISON OF MUTATION INDUCTION BY 14 MeV FAST NEUTRONS AND ^{137}Cs γ RAYS IN MEIOTIC SPERMATOCYTES IN THE SILKWORM. Murakami, Akio (National Inst. of Genetics, Mishima, Japan). Mutat. Res.; 17: No. 1, 73-80 (Jan 1973).

The results of experiments on the relative biological effectiveness (RBE) of 14 MeV fast neutrons as compared with ^{137}Cs γ rays for recessive visible mutation induction on the primary meiotic spermatocytes in the silkworm are presented. 1-day-old fifth instar silkworm larvae were treated with five different doses (167, 250, 500, 684, and 1000 R) of γ rays, or three different doses (160, 250, and 540 rad) of 14 MeV neutrons. Mutations at the pe and re loci were detected by the egg-color specific locus method. Primary meiotic spermatocytes showed an extremely high radiosensitivity of cell killing that was not previously found in postmeiotic cells. With 1000 R of γ rays and 540 rad of neutrons, more than 90% of the cells in meiotic divisions were killed. However, these effects were negligible with lower doses either for neutrons (160 and 250 rad) or γ rays (167, 250, and 500 R). Hence the results presented are from the remaining low doses for both radiations. The average mutation rate obtained on the two loci was $0.9 \cdot 10^{-6}$ per rad for γ rays and $1.9 \cdot 10^{-6}$ per rad for neutrons. The mutation rate for γ rays was somewhat lower than that of spermatids which have the highest rate throughout spermatogenesis. The RBE of 14 MeV neutrons was determined only for whole-body mutants because the frequency of fractional-body mutants was nearly the same as the control. The initial dose mutation frequency for both loci and both radiations were almost linear at lower doses, though at higher doses they tended to reach a maximum followed by a decline in mutation frequency. The RBE was calculated on the assumption that the dose-response curve was linear in lower dose regions. Thus, RBE values, as the ratio of the slope of the weighted linear regression line for neutrons to γ rays, were estimated to be 1.7 at the pe locus and 2.2 at the re locus. These values are about one-third of those for mature sperm and are much the same as those in primordial germ cells and in spermatogonia. (auth)

9879 ULTRAVIOLET IRRADIATION OF HERPES SIMPLEX VIRUS: REACTIVATION PROCESSES AND DELAY IN VIRUS MULTIPLICATION. Ross, L. J. N.; Cameron, K. R.; Wildy, P. (Univ. of Birmingham, Eng.). J. Gen. Virol.; 16: No. 3, 299-311(Sep 1972).

The small-plaque effect induced by exposure of herpes simplex virus to uv light was investigated. New results are presented showing that the effect was due to a delay of multiplication of virus in the cells initiating plaques. The delay occurred after entry of virus into the cell and before the replication of virus. The ultimate cause of the delay was probably the formation of thymine dimers since the small-plaque effect was reversed by photoreactivation in avian cells. Evidence was obtained for cooperative reactivation and host-cell reactivation in infected BHK cells but neither of these phenomena could be related to the small-plaque effect. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstract 9841.

9880 FURTHER INVESTIGATIONS OF THE TRANSFER OF BOMB ^{14}C TO MAN. Harkness, D. D.; Walton, A. (Scottish Research Reactor Centre, East Kilbride, Scotland). Nature (London); 240: No. 5379, 302-3(1 Dec 1972).

A study was made of the mean dietary intake of ^{14}C by the UK population, and an assessment was made of the possible application of temporal changes in "bomb ^{14}C" concentrations as a tracer for human metabolic processes. Concentrations of ^{14}C in selected dietary components were monitored over the period 1967 to 1969. Good correlations were found between the ^{14}C concentrations in foods of terrestrial origin and the atmospheric concentrations, and it would appear that the time involved for the transfer of C through the major pathways of the food chain is short. The most significant deviations resulted from the low concentrations of ^{14}C in foods of marine origin, the values reflecting the concentrations reported for C dissolved in the oceanic euphotic zone. Concentrations of ^{14}C in diet were compared with those measured in blood, and the question as to whether the temporal variations reported for ^{14}C in blood are representative of all body tissue was examined. It is anticipated that concentrations of ^{14}C in living structures will parallel the present steady atmospheric decline. (UK)

Animals

Refer also to abstracts 9851 and 9854.

9881 (AEC-tr-7387, pp 214-511) REMOTE AFTEREFFECTS CAUSED BY EXPOSURE TO RADIOACTIVE ISOTOPES. Translated from pp 197-464 of Otdalennye Posledstviya Luchevykh Porazhenii, Atomizdat, Moscow, 1971.

AMERICIUM-241—effects on dogs and rats following intraperitoneal or intravenous injection as chloride, citrate, or nitrate, comparison of delayed pathological
—effects on ovaries and function of sex glands in female rats following intravenous injection as citrate, delayed pathological
—effects on postnatal development of rat offspring following intravenous injection as citrate in dam, delayed pathological

AMMONIUM URANATES—effects on rats following chronic inhalation as aerosol, delayed pathological

CERIUM-144—effects on rabbit lungs following ingestion as colloidal fluoride solution, delayed neoplastic

FISSION PRODUCTS—effects of uranium, on central nervous system of rats following inhalation as aerosol or ingestion, delayed pathological

NEPTUNIUM-237—effects on rats following intratracheal or intravenous injection as nitrate or oxalate, delayed pathological

PLUTONIUM-239—effects on lungs of rabbits and rats following inhalation as carbonate or citrate aerosols, effects of dose on delayed pathological
—effects on rats following subcutaneous injection as carbonate or citrate, delayed pathological
—effects on rats following chronic ingestion as citrate, role of skeletal distribution in development of delayed pathological
—effects on metabolic processes in bone tissues of dogs, rabbits, and rats following injection as nitrate, comparison of delayed pathological
—effects on bones and lungs of rats following inhalation as soluble compounds in aerosols, effects of pentazine, prednisolone, and streptomycin on incidence of delayed pathological

POLONIUM-210—effects on central nervous system, hematological parameters, immune reactions, and internal organs of dogs following subcutaneous injection, delayed pathological

PROTACTINIUM-233—effects on rats following intravenous injection as citrate solution, effects of dose on delayed pathological

STRONTIUM-90—effects on offspring of dogs following chronic low dose ingestion by dam, delayed pathological
—effects on bones, hematopoietic system, and phagocytic activity of neutrophils in dogs following chronic low dose ingestion, effects of dose on delayed pathological and tumorigenic
—effects on central nervous system of dogs following intravenous injection or ingestion, delayed tumorigenic

TRITIUM—effects on postnatal development of rat offspring following chronic internal exposure of dam to tritium oxide

URANYL NITRATES—effects on morphology and physiology of dogs following single subcutaneous injection, delayed pathological (E.R.B.)

9882 EFFECT OF RADIOACTIVE WATER ON THE OXYGEN CONSUMPTION OF CEREBRAL AND HEPATIC TISSUE. Armijo Valenzuela, M.; Arevalo Alonso, J. M. (Inst. of Experimental Pharmacology, Madrid). Arch. Inst. Farmacol. Exp. (Madrid); 23: 103-6(1971). (In Spanish).

Radioactive water with radioactivity of 10, 50, and 100 nCi/liter was administered to male rats. The rats were decapitated and sections of cerebral tissue and homogenized samples were tested for the oxygen consumption. The results were tabulated and show no appreciable modification as the result of drinking and 10 to 50 nCi/liter water, but there was a significant decrease for the 100 nCi/liter water. In the hepatic tissue there was a general inhibiting effect on the consumption of oxygen, which was only significant at the highest concentration and in the homogenized samples. The significance of these results was discussed. (J.S.R.)

Nuclide Kinetics and Toxicology

Man

Refer also to abstract 9265.

9883 CHANGES IN THE NORMAL RANGE OF THYROIDAL RADIOIODINE UPTAKE. Keeling, D. H.; Williams, E. S. (Middlesex Hospital, London). J. Clin. Pathol.; 25: No. 10, 863-6(Oct 1972).

Three series of patients shown to be euthyroid but originally referred for thyroid uptake tests in vivo have been compared. In 1958 to 1959, the normal mean thyroid uptake was 23.5 and 38.2% respectively at 4 and 24 hrs. By 1967, the mean uptakes had dropped to 20.4 and 31.6%, a significant change at both times. By 1972 there was, however, no sign of a further reduction of the mean normal values for thyroid uptake. These results are compared with changes observed in other series in the USA and Britain. (auth)

9884 NOTE ON SOME ASPECTS OF SKIN CONTAMINATION BY CERTAIN RADIONUCLIDES IN COMMON USE. Henson, P. W. (Royal Perth Hospital, Melbourne). Brit. J. Radiol.; 45: No. 540, 938-43(Dec 1972).

Calculations were made of skin dose-rates resulting from uniform contamination with a number of commonly used radionuclides, on the assumption that no skin penetration occurs. Dose-rates from low-energy x rays, γ rays, conversion electrons, and β particles were calculated for the skin basal layer range and to a depth of 1 mm. It was found that four short-lived radionuclides, ^{68}Ga, ^{87m}Sr, ^{99m}Tc and ^{113m}In, may deliver doses of 5 to 10 rads to the basal layer if permitted to remain on the skin at levels of 1 $\mu Ci/cm^2$ for periods of hours. With the exception of ^{68}Ga, the dose results primarily from conversion electron emission from these radionuclides. Dose-rates in the basal layer from the surface derived working limits (DWL) of 10^{-4} $\mu Ci/cm^2$ were compared and it was found that some γ emitters, e.g., ^{113m}In and ^{169}Yb, give values comparable to those from β emitters, owing to their conversion electron emission. It was pointed out that care should therefore be taken not to underestimate the hazards of γ contamination in comparison to those from β emitters. Basal-layer dose-rates from the DWL for ^{51}Cr and ^{125}I were found to be approximately one tenth of those from other radionuclides examined. Support is thus lent to a proposal in the literature that the DWL for these radionuclides be relaxed by a factor of 10. (auth)

Animals

Refer also to abstracts 9571 and 9874.

Plants

9885 UPTAKE AND BINDING OF URANYL IONS BY BARLEY ROOTS. Robards, A. W.; Robb, M. E. (Univ. of York, Heslington, Eng.). Science; 178: No. 4064, 980-2(1 Dec 1972).

After undergoing the processing for electron microscopy, bound uranyl ions are revealed as characteristic electron-opaque crystals. Meristematic walls and associated vesicles become heavily labeled, while pinocytotic accumulation into vacuoles seems probable in cap cells and those just behind the meristem. The endodermal Casparian strip and suberinized lamella are effective barriers to the passage of uranyl ions. (auth)

New Tracer Techniques

9886 (BARC-604) INVESTIGATION OF LINEAR SCANNING AND PLANAR TECHNIQUES BY IN-VIVO COUNTING OF ^{42}K USING A LARGE VOLUME PLASTIC SCINTILLATION INFANT COUNTER. Hukkoo, R. K.; Surendran, T.; Unnikrishnan, K.; Somasundaram, S. (Bhabha Atomic Research Centre, Bombay (India)). 1972. 33p. Dep. NTIS (U. S. Sales Only).

For the estimation of total body potassium in infants various counting geometries are devised and experimentally evaluated by administering small amount of ^{42}K to infants. The counting system located inside Trombay steel room consists of two large volume (18 litres each) plastic scintillator (type NE102A) detectors. Each detector is in the form of a cylinder with an elliptical cross section and placed above and below a supine infant. The subjects of this study include normal Indian infants and those suffering from protein malnutrition (PCM) aged up to 3 years. In the fixed bed system the infant is positioned asymmetric with respect to the vertical mid-axis of the detectors such as to yield the highest counting rate. The simulation of a system consisting of four detectors with two of them positioned in a roof type configuration over and the other two below the infant is also achieved with the present positioning of the detectors. The scanning bed geometry employs scanning orbit length equal to the height of the infant. Measurements have been carried out on thirty-nine infants in all the above mentioned geometries of counting and data analyzed to evaluate the dependence of calibration factor on height and weight of infants. Data are also presented on the total body potassium in normal Indian infants. (auth)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 9426, 9503, 9558, 9658, 9775, 9939, 9941, 9972, 9988, 9991, 10017, 10027, 10045, 11213, 11218, 11223, 11226, 11227, 11233, 11242, 11290, 11476, and 11522.

9887 (AI-CE-Memo-9) HEAVY WATER ORGANIC COOLED REACTOR. IRRADIATION BEHAVIOR OF UNALLOYED URANIUM CARBIDE. Frank, J. E. (Atomics International, Canoga Park, Calif.). 8 Apr 1966. Contract AT-(38-1)-430. 46p. Dep. NTIS.

An evaluation of the available irradiation data on unalloyed uranium carbide fuels is presented. Design values for fission gas release and fuel volume changes for hyperstoichiometric uranium carbide are recommended, but must be updated as more data become available. The analysis indicated that (a) fuel volume increases are directly proportional to burnups to at least 30,000 Mwd/T at fuel centerline average temperatures of at least 1800°F, (b) fuel volume changes are composition-dependent, (c) fission gas release is composition-dependent, (d) variations in preirradiation density do not appear to significantly affect fuel volume changes, and (e) fission gas release grossly increases with decreasing preirradiation fuel density. Insight into the factors affecting the irradiation behavior of UC fuels is offered. (auth)

9888 (GULF-GA-A-12195) REVIEW OF CERAMIC DRIVER FUEL ELEMENTS FOR THERMIONIC REACTORS. Simnad, Massoud (Gulf General Atomic Co., San Diego, Calif.). 15 Sep 1972. Contract AT(04-3)-840. 64p. Dep. NTIS.

The feasibility of using the ceramic fuels UO_2, UC, and UN in driver fuel elements for the Thermionic Reactor Experiment (TREX) is appraised. The results of extensive irradiation tests of these fuels are summarized on the basis of their relevance to the thermionic reactor driver fuel elements. It is concluded that all of these ceramic fuels are suitable for use as driver fuels in the TREX. (auth)

9889 (LA-5094) INTERNAL REACTION PHENOMENA IN PROTOTYPE SUBTERRENE RADIANT HEATER PENETRATORS. Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 9p. Dep. NTIS.

Internal chemical reactivity in prototype subterrene radiant heater penetrators has been investigated by means of sectioning and examination of metallurgical samples. Formation of dimolybdenum carbide, Mo_2C, is the major reaction product formed between the base metal and the graphite receptor interface. In those regions where carbiding has occurred, temperatures have been calculated by means of measurement of the carbide layer thickness and the use of reaction rate data for the Mo–C system. These temperatures are compared with those computed from heat transfer considerations. Agreement is reasonably good in those regions where the carbide layer has not delaminated internally. The formation of defects in the carbide layer with resulting perturbation of normal state carbon diffusion, however, implies a limited utility to this technique for the determination of operating temperatures. A brief discussion concerning lifetime predictability is presented. (auth)

9890 (RISO-269) IN-REACTOR DETERMINATION OF THE THERMAL CONDUCTIVITY OF UO_2-PELLETS UP TO 2200°C. Fayl, G.; Hansen, K. (Danish Atomic Energy Commission, Risoe, Research Establishment). Jul 1972. 35p. Dep. NTIS (U. S. Sales Only).

The thermal conductivity of sintered stoichiometric UO_2 pellets was determined in the temperature range 500 to 2200°C and at different burnup levels from 0 to 0.8×10^{20} fiss/cm^3. The conductivity was evaluated from temperature measurements at the center and two off-center positions in the UO_2 pellets. The power was determined by thermocouples measuring temperature differences in the heat conduction path out from the UO_2 pellets. These thermocouples were power-calibrated by means of an electric furnace. The rig design makes it possible to replace the centrally positioned thermocouple (during reactor shut-down) in the event of thermocouple failure or to eliminate irradiation-induced changes in its emf-characteristic. Furthermore, it is possible to replace the gases in the fuel capsule in order to investigate the influence of fission gases on the fuel to cladding heat transfer. The results showed good agreement with literature data on thermal conductivity of UO_2 early in the irradiation (burn up $\approx 10^{19}$ fiss/cm^3). A reduction in the thermal conductivity, with burnup, was found at temperatures below 1000°C. This reduction caused a 9% increase of center fuel temperature at a linear heat rating of 350 W/cm, after 0.8×10^{20} fiss/cm^3. No influence of burnup on the thermal conductivity above 1000°C was found. Also, there was no influence of fission gases on the fuel to cladding heat transfer (initial gap = 0.57% of fuel diameter). With regard to the rig design, the system for exchange of the central thermocouple seems to be limited to a maximum fuel temperature of 1400°C. (auth)

9891 (UJV-2853-M) THERMODYNAMIC AND TRANSPORT PROPERTIES IN UO_2–PuO_2 AND RELATED SYSTEM. I. SYSTEM UO_2–PuO_2 AND SYSTEM UO_2–ThO_2. Jakesova, L. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1972. 56p. (In Czech). Dep. NTIS (U. S. Sales Only).

The thermodynamic and transport properties of U–Pu–O and U–Th–O systems are reviewed. Special attention is given to phase relations, phase diagrams, evaporation properties, partial molar properties thermal conductivity, electric resistance activity of UO_2, and diffusion coefficients of mixed oxides. Data are summarized in tables and graphs and the similarity between U–Pu–O and U–Th–O systems are discussed. (auth)

9892 INVESTIGATION IN THE SINTERING OF Y_2O_3 POWDERS IN THE TEMPERATURE RANGE 1000 TO 1400°C. Kostic, E.; Ristic, M. M. (Boris Kidric Inst. of Nuclear Science, Belgrade). J. Mater. Sci.; 7: No. 11, 1322-6(Nov 1972).

A study is presented of the sintering of two Y_2O_3 powders in the temperature range where only minor densification occurs. Two powders were examined; one powder, Y_2O_3-A, was obtained by decomposition of hydroxide, because earlier examinations showed that use of this powder resulted in the highest densities of samples in the sintering temperature range from 1300 to 1900°C. The second powder, Y_2O_3-D, was purchased externally. In order to ensure that the pores in the Y_2O_3-A compacts closed as late as possible, the heating rates up to the appropriate temperatures (1000 to 1400°C) were varied in the range 0.013 to 6°C sec^{-1}. The results obtained show that the heating rate in this temperature range, for the powder obtained by decomposition of hydroxide, is of primary importance in the densification of the material, and that cessation of shrinkage was not observed in the period of 240 min. (auth)

9893 ENHANCEMENT OF TUNGSTEN–CARBIDE TOOL LIFE BY OXIDE TREATMENT. Suh, N. P.; Shyam, S.; Naik, S. K. (Massachusetts Inst. of Tech., Cambridge). J. Eng. Ind.; 94: No. 4, 979-84(Nov 1972).

It is shown that the tool life of tungsten-carbide tools can be increased by at least 80% by treating the surface of carbide tools with various oxides. Among the oxides that increase the tool life are titanium dioxide, zirconium oxide, aluminum oxide, and chromium sesquioxide. The oxide treatment was done by diffusing the oxide layer, which had been coated on the tool surface, into the subsurface layer in a vacuum of 10^{-5} torr at various temperatures. The increase in tool life is greater at higher temperatures of the oxide treatment, the maximum temperature being the sintering temperature of the carbide tools. It is believed that the decrease in the tool wear rate is caused by the retardation of mass diffusion between the tool and work, lowering of the chip-tool interfacial friction, and by decrease in the temperature at the chip-tool interface. Other possible causes are also discussed. (auth)

9894 PRACTICAL FIELD REPAIR OF FUSED SLURRY SILICIDE COATING FOR SPACE SHUTTLE T.P.S. Reznik, Barry D. (GTE-Sylvania Inc., Hicksville, N. Y.). pp 371-8 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

A study of short-time high-temperature diffusion treatments was performed. The metallographic structure and oxidation behavior of R512E applied to Cb-752 coated under simulated field repair conditions was determined. Oxidation testing in reduced pressure environment showed that performance equivalent to furnace processed specimens can be obtained in a 2-minute diffusion at 2700°F. A hand-held, portable infrared heater was modified to allow for in-field repair. Typical repairs were made and evaluated by metallographic examination and oxidation testing. (auth)

9895 STRUCTURAL CHARACTERISTICS OF A ZIRCONIUM DIBORIDE COMPOSITION FOR APPLICATION TO HOT LEADING EDGES. Strauss, Eric L. (Martin Marietta Corp., Denver);

Clougherty, Edward V.; Boensch, Frank D. pp 473-90 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Diboride VIII, a hot pressed zirconium diboride–silicon carbide–graphite composition, is being investigated for application as nose tips and leading edges of lifting entry vehicles. A series of tension and flexural tests were conducted to determine the mechanical behavior of the material for component design. These tests provided data on high temperature strength, directional properties, size effects, and on the effects of stress concentrations and flaws on material strength. (auth)

9896 EXPERIMENTAL EVALUATION OF LIGHTNING PROTECTIVE COATINGS FOR BORON/EPOXY COMPOSITES. Schulte, E. H.; Clifford, D. W. (McDonnell Aircraft Co., St. Louis). pp 707-15 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

A number of candidate lightning protective coatings for composite structural materials have been evaluated in the McDonnell Aircraft Company (MCAIR) Lightning Simulation Laboratory. Emphasis has been placed on coating parameter optimization and elucidation of damage mechanisms. Coated and uncoated aluminum foils, plasma sprayed aluminum, aluminum meshes, and bronze meshes, on dielectric substrates were tested by exposure to simulated high current lightning strikes. (auth)

9897 SPACE SHUTTLE ORIENTED POLYIMIDE MATRIX COMPOSITE STUDIES. Korb, L. J.; Nadler, M. A. (North American Rockwell, Downey, Calif.). pp 725-34 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The results of polyimide matrix composite studies made at the Space Division of the North American Rockwell Corporation are presented. These studies cover characterization of the properties of candidate polyimide systems, modifications of composite testing technology, fabrication and test of composite structural elements, and preliminary design studies of the titanium structure for the Space Shuttle selectively reinforced with boron/polyimide composite. These studies indicated that a composite reinforced cargo door version of the straight wing shuttle orbiter configuration resulted in a 560 lb weight saving (21%) over the all-metal design. The wing rear spar shear web study indicated a saving of 102 lb (27%). Producibility considerations showed that in both cases the flat and/or simply curved shape of the composite details permitted their fabrication from platen press molded blanks. High temperature resistant addition reaction curing polyimide resins can therefore be used which are not amenable to conventional autoclave cure cycles. Low void content, high quality, low rejection rates, and relatively low production costs are anticipated for this approach. (auth)

9898 CUBIC-TETRAGONAL TRANSFORMATION IN METAL DICARBIDES. 1. THE URANIUM–LANTHANUM AND URANIUM–CERIUM DICARBIDE SYSTEMS. McColm, I. J.; Colquhoun, I. (Univ. of Bradford, Eng.). J. Inorg. Nucl. Chem.; 34: No. 12, 3809-19(Dec 1972).

The composition dependence of the cubic → tetragonal phase transformation for solid solutions of UC_2 with LaC_2 and with CeC_2 is reported. The existence of cubic phases down to room temperature is shown for ternary carbides within the composition limits $La_{0.10}U_{0.90}C_2$ to $La_{0.85}U_{0.15}C_2$ and $Ce_{0.16}U_{0.84}C_2$ to $Ce_{0.81}U_{0.19}C_2$. A disordered domain model is described to account for the failure of a tetragonal phase to nucleate on cooling from the melt. The variations of lattice parameter with composition for the cubic solid solutions are given. The appearance of UC from the cubic solid solutions on annealing shows that UC precipitation occurs above the $\beta \rightarrow \alpha$ transition. Ternary fcc solid solutions containing C_2 units have been shown not to occur when the overall carbon/total metal ratio falls below 2:1. In such preparations the phases in the melt are UC and the lanthanide carbide expected from the melt stoichiometry. The limiting solubilities of Ce in UC and of U in Ce_2C_3 are 4.5% and 5.5 atom % total metal respectively. (auth)

9899 CORROSION RESISTANCE OF CHROMIUM AND TANTALUM DIBORIDES AND THEIR ALLOYS IN HIGH-PARAMETER WATER. Arabey, B. G.; Myshkin, V. A.; Tikhonova, R. S.; Frolova, K. I. Zashch. Metal.; 7: No. 1, 16-19(1971). (In Russian).

It was shown experimentally that a firmly attached, nonflaking dark green film is formed on CrB_2 and CrB_2–40% TaB_2 during corrosion tests, while the film on CrB_2–60% TaB_2 is loose, porous and of a brownish color. TaB_2 specimens become coated with a light-grey pasty mass. After drying, cracks form on the surface, along which fracture of the specimens occurs. On specimens of TaB_2 with 8, 10, and 12% porosity, the mass increases in the initial testing period (approximately 150 hours), then begins to decrease when the pores are filled with corrosion products. A considerable increase in the mass at 10 to 15% porosity is also observed with specimens of CrB_2, TaB_2–40% CrB_2 and TaB_2–60% CrB_2. For specimens with porosity below 5%, homogenizing annealing substantially reduces change in the mass. Results of tests on annealed specimens show CrB_2 to be stable up to 300°C, and CrB_2–60% TaB_2—up to 250°C, with TaB_2 stable up to 150°C. At higher temperatures, the diborides and their alloys react vigorously with water. (Referativnyi Zh.)

9900 PHASE COMPOSITION AND ELECTROCONDUCTIVITY IN THE La_2O_3–SrO SYSTEM. Volchenkova, Z. S.; Pal'guev, S. F. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 122-7(1970). (In Russian).

The phase compositions of La_2O_3–SrO samples which had been sintered in air were determined by x-ray analysis. The change in total electrical conductivity with temperature and composition was related to the phase relationships involved. The formation of a heterotypic solid solution based on La_2O_3 was accompanied by a sharp rise in the conductivity; this was not observed in the case of SrO. A chemical compound could not be detected in this system. (tr-auth)

9901 STRUCTURE AND ELECTROCONDUCTIVITY IN THE ZrO_2–Y_2O_3–Fe_2O_3 AND ZrO_2–Y_2O_3–MnO_2 SYSTEMS. Kotlyar, A. G.; Neuimin, A. D.; Pal'guev, S. F.; (and others). Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 128-34(1970). (In Russian).

The structure and the electrical conductivity were investigated in the systems ZrO_2–Y_2O_3–Fe_2O_3 and ZrO_2–Y_2O_3–MnO_2 for the series of compositions 0.9 ZrO_2–0.1(Y_2O_3–M_2O_3), where M = Fe or Mn. For mixtures in this range which had been sintered at 1,500 to 1,550°C, a fluorite type solid solution was characteristic. Complete stabilization of the cubic ZrO_2 was observed only in samples with 2 and 4 mole % Fe_2O_3. A monoclinic-tetragonal conversion of ZrO_2 in the presence of Y_2O_3 or MnO_2 began at 900°C; the fluorite phase was distinctly fixed at 1,100°C. In the cubic solid solutions polyvalent ions of Fe and Mn largely occupied nodes in the cation sub-lattice. Samples with two and four percent M_2O_3 possessed a high ionic conductivity. (tr-auth)

9902 STRUCTURE AND ELECTROCONDUCTIVITY IN THE ZrO_2–Y_2O_3–WO_3 SYSTEM. Kotlyar, A. G.; Neuimin, A. D.; Pal'guev, S. F.; (and others). Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 135-7(1970). (In Russian).

The structure and electrical conductivity were investigated for a series of compositions in the system ZrO_2–Y_2O_3–WO_3. Stabilization of cubic ZrO_2 was hindered by the addition of WO_3 to the 0.9 ZrO_2–0.1 Y_2O_3 mixture. The introduction of up to 5 mole% WO_3 to the latter mixture sharply decreased its electrical conductivity. (tr-auth)

9903 INVESTIGATION OF OXIDE MATERIALS BY HIGH-TEMPERATURE X-RAY TECHNIQUES. IV. INTERACTION OF ZrO_2 WITH Yb_2O_3. Strekalovskii, V. N.; Pal'guev, S. F.; Zubankov, V. N. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 138-44(1970). (In Russian).

The interaction of ZrO_2 with Yb_2O_3 was studied at temperatures up to 1,580°C by means of high-temperature x-ray techniques. The transition of low-temperature α-ZrO_2 into its low-temperature β-form was observed in mixtures to 33.3% mole% Yb_2O_3 in the range 1,100 to 1,250°C., resulting in fluorite-like solid solutions of Yb_2O_3 in β-ZrO_2. Additions of up to 4 mole% Al_2O_3 promoted the stabilization of ZrO_2. (tr-auth)

9904 INVESTIGATION OF OXIDE MATERIALS BY HIGH-TEMPERATURE X-RAY TECHNIQUES. V. INTERACTION OF ZrO_2 WITH Sc_2O_3. Strekalovskii, V. N.; Pal'guev, S. F.; Zubankov, V. N. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 145-53(1970). (In Russian).

The products of interaction of ZrO_2 with Sc_2O_3 at temperatures up to 1,580°C were investigated with high-temperature x ray techniques. A series of fluorite-similar phases formed which could be distinguished by their x ray spectra. In this respect the ZrO_2–Sc_2O_3 system differed from the ZrO_2–R_2O_3, where R = a rare earth element. (tr-auth)

9905 IMPROVEMENTS IN OR RELATING TO METHODS OF FORMING NUCLEAR FUEL BODIES. Sturge, D. W. J. (to United Kingdom Atomic Energy Authority). British Patent 1,286,286. 23 Aug 1972. Filed 20 Oct 1969.

An improved process for the manufacture of coated-particle fuel dispersed in a matrix material is described. In conventional processes, difficulties arise in ensuring that the die or mold employed is left clean for re-use. In this improved process a mold release agent is incorporated in the overcoating material, before application to the fuel particles, and then subjecting the mass of material to a pressure molding process. Stearic acid is a suitable mold release agent. (UK)

9906 METHOD OF FILLING UP HOLLOW ISOTROPIC GRAPHITE PEBBLES OF HIGH TEMPERATURE GAS COOLED REACTORS. Pernollet, A.; Slonina, J.-P. (to Societe le Carbone Lorraine). French Patent 1,604,016. 28 Jun 1971. Filed 6 Dec 1968. (In French).

A process is described in which expanded graphite obtained from lamellar natural graphite complexes is used to pack coated fuel particles inside hollow pebbles. (France)

9907 SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS OF REFRACTORY INORGANIC COMPOUNDS. Merzhanov, A. G.; Borovinskaya, I. P. (Inst of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 2, 366-9(11 May 1972). (In Russian).

A novel approach to the synthesis of refractory compounds was based on interaction characteristics of the majority of elements in the periodic system with B, C, N, Si, and others: a high heat of formation of the products or a large activation energy. Constant pressure bombs and reactors were utilized in the production of the carbides of Ti, Zr, Hf, Ta, the nitrides of Nb, Zr, Ta, Hf, and B, and the borides of Zr, Ti, Hf, and Mo. The synthesis depended on the ability of a reaction to move through a substance as a result of heat transmission from a local initiation of the reaction in an unheated mixture of reagents, and received the name "self-propagating high-temperature synthesis." (K.S.W.)

9908 IMPROVEMENTS IN OR RELATING TO THE PREPARATION OF MATERIALS OF THE GENERAL TYPE COMPRISING MIXED OXIDES. Grimes, J. H.; Lane, E. S. (to United Kingdom Atomic Energy Authority). British Patent 1,286,257. 23 Aug 1972. Filed 14 Oct 1968.

A process is described for the formation of mixed oxides comprising precipitating at least one metal oxide, or a compound decomposable to an oxide, in the form of gel particles containing a protective agent, then contacting the gel particles with a solution of a compound of another metal that is decomposable on heating to produce oxide, and heating the gel particles to produce particles of the mixed oxides. The gel particles may comprise ZrO_2 and the other metal compound may be $UO_2(NO_3)_2$. The protective agent is a substance for imparting the property of gelling in the presence of a precipitating agent, such as a base. The process may also be used for the production of ThO_2 gels. (UK)

9909 EFFECT OF HIGH PRESSURE ON THE PHASE COMPOSITION OF ALLOYS OF SiC WITH BORON. Kalinina, A. A.; Sokhor, M. I.; Shamrai, F. I.; Kovaleva, A. F. (All-Union Scientific-Research Inst. of Abrasives and Grinding, Leningrad). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 728-31(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 839-42(May 1972).

Results of investigations are presented which show that the polymorphic transition $\alpha \rightarrow \beta$-SiC occurs in alloys of SiC with boron under the effects of pressures of 50 to 60 kbar and temperatures higher than 1700°C. The structure of the principal phase (SiC) and the other phases (Si and B_4C) becomes finely dispersed and the crystal lattices of all the phases acquire considerable stresses. Alloys with less than 1% boron, sintered under high pressure, have high densities. Such alloys are of practical value. (auth)

9910 CARBONITRIDE AND OXYCARBIDE PHASES OF TITANIUM AND ZIRCONIUM. Klimashin, G. M.; Avgustinik, A. I.; Smirnov, G. V. (Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 732-4(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 843-5(May 1972).

Results of investigations are reported in which titanium and zirconium oxycarbides and carbonitrides were synthesized in a wide concentration range in a vacuum of 10^{-3} to 10^{-5} mm Hg at 2020 to 2300°K. The synthesized specimens have been subjected to metallographic, chemical, and x-ray analysis. The regions of existence of one-phase solid solutions have been established. (auth)

9911 CONDITIONS AND MECHANISM OF FORMATION OF SUBOXIDE PHASES IN THE SYSTEM NIOBIUM–OXYGEN. Dekanenko, V. M.; Vavilova, V. V.; Kornilov, I. I. (Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 738-41(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 849-52(May 1972).

Results of studies of Nb oxidation are presented showing that a suboxide of the composition Nb_4O is formed when a solid solution containing 1.5 at.% oxygen decomposes during annealing at 500 to 700°C. According to electron-microscopic analysis, Nb_4O has a laminar structure with lattice constants $a = 2a_{Nb} = 6.65$ Å, $c = a_{Nb} = 3.32$ Å and $c/a = 0.5$. Segregation of Nb_4O at high oxygen contents of the niobium-based solid solution was not observed. Formation of Nb_4O in an alloy with a low oxygen content is probably due to the tendency of solid solutions of niobium with oxygen to undergo ordering even at low oxygen contents. It is suggested that, owing to the difficulty of rearrangement, at low temperatures, of the niobium lattice to the NaCl-type lattice of NbO, this transition is effected gradually via a series of intermediate phases which are suboxides. (auth)

9912 PHYSICOCHEMICAL REACTIONS OF DYSPROSIUM, YTTRIUM, AND YTTERBIUM OXIDES WITH BARIUM OXIDE. Lopato, L. M.; Maister, I. M.; Shevchenko, A. V. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 749-51(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 861-4(May 1972).

Phase diagrams were constructed of the systems Dy_2O_3–BaO, Y_2O_3–BaO, and Yb_2O_3–BaO. The phase ratios in the systems Ho_2O_3–BaO, Er_2O_3–BaO, Tm_2O_3–BaO and Lu_2O_3–BaO were studied. It was found that these systems contain compounds of 1:1 ($CaFe_2O_4$) and 2:3 (hexagonal structure) composition. Their physicochemical properties were also studied. Additions of barium oxide reduce the polymorphic transition points of rare earth oxides. (auth)

9913 ESTIMATE OF THE TEMPERATURE DEPENDENCES OF INTERIONIC DISTANCES AND THEIR INFLUENCE ON DEMIXING IN SILICATE MELTS AND GLASSES. Min'ko, N. I.; Fabrikant, S. A. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 806-11(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 927-33(May 1972).

Calculations were made on the temperature coefficient $(\partial r_T / \partial T)_p$ and the change in interionic metal-oxygen distance Δr in the range 800 to 1923°K in comparison with r_0 for standard temperature for the oxides used in the synthesis of various glasses. Relatively marked increase in the interionic distance with rise of temperature is observed in the oxides of univalent elements; as the valence increases, the variation of interionic distance with temperature decreases. The energetic abilities of individual cations to cause demixing of a silicate melt at standard and elevated temperatures were estimated. Variation of the ionic radii with temperature has no influence on the capabilities of the individual cations to cause demixing of a silicate melt. (auth)

9914 EFFECT OF OXYGEN, PRESENT AS AN IMPURITY, ON THE LATTICE CONSTANT OF ZIRCONIUM CARBIDE. Rymashevskii, G. A.; Gurevich, B. D.; Kossykh, V. G.; Kutyreva, G. A. Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 830-1(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 952-3(May 1972).

Specimens were prepared for use in determining the effects of O on the lattice constant of ZrC by sintering mixtures of ZrC and ZrO_2 powders. Results of analyses of these specimens show that increase in the oxygen content reduces the lattice constant of ZrC. This reduction is attributed to ordering. (J.R.D.)

9915 SOLUBILITY OF LANTHANUM AND NEODYMIUM OXIDES IN FUSED FLUORIDES. Belov, S. F.; Gladneva, A. F.; Matveev, V. A.; Igumnov, M. S. (Moscow Inst. of Fine Chemical Tech.). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 845-7 (May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 966-7(May 1972).

Results of studies are presented on the solubility of La_2O_3 and Nd_2O_3 in AlF_3, LiF, NaF, KF, and RbF. (J.R.D.)

9916 PHASE EQUILIBRIA IN THE SYSTEM Dy_2O_3–WO_3. Ivanova, M. M.; Reznik, E. M. (Inst. of General and Inorganic Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 863-5(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 981-3(May 1972).

The phase equilibria were studied in the concentration range of 0 to 50 mole % Dy_2O_3. Data on the phase composition were obtained in the range 50 to 100 mole % Dy_2O_3. (J.R.D.)

9917 INVESTIGATION OF VANADIUM OXIDE–TUNGSTEN OXIDE CATALYSTS FOR METHANOL OXIDATION TO FORMALDEHYDE. Kurina, L. N.; Sterligova, G. I. (Tomsk State Univ., USSR). Kinet. Katal.; 13: No. 4, 942-8(1972). (In Russian).

Phase composition of the V_2O_5–WO_3 system was studied by x-ray diffraction, electric conductivity, infrared spectroscopy, and EPR. In concentrations up to 10 mole% WO_3 the formation of a solid solution was observed, giving rise to the appearance of V^{4+} in the system and an increase in the electroconductivity and catalytic activity. The introduction of a second component changed the character of the metal-oxygen bond in the crystal lattice of V_2O_5. (tr-auth)

9918 DISTRIBUTION OF RARE EARTH IMPURITIES IN SINGLE CRYSTALS OF STRONTIUM FLUORIDE. Zyryanov, A. P.; Rivkina, K. K.; Shul'gin, B. V.; (and others) (Urals Polytechnic Inst., Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 5, 848-9(May 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 5, 968-9(May 1972).

Activation investigations using thermal neutrons revealed that the distribution of rare earth impurities along the growth axes of the crystals is very nonuniform; as a rule, the deviation of the concentration from the mean is most marked for charges with low impurity content (Tb,Dy). The distribution of impurities over the bulk of the single crystal of SrF_2 depends on the growth conditions. The possibility of monitoring the impurity distribution will lead to corrections for the synthesis conditions. (auth)

9919 FACTORS CONTROLLING THE SHAPE REGULARITY OF SINTERED UO_2 PELLETS. Flipot, A. J.; Smolders, A. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Powder Met.; 15: No. 30, 290-313(1972).

As explained mathematically, the magnitude of the "diabolo" effect in sintered nuclear fuel pellets is a function of the slope and position of the sinterability curve and the density gradient existing in the green pellets. If sinterability is represented by a straight line passing through the origin, the diabolo effect is negligible; this condition can be fulfilled when using a deactivated powder. In any other case, the density gradient must be kept as low as possible to produce sintered pellets of regular shape. This is discussed as a function of powder roughness, lubricant quality, lubrication technique, and compaction characteristics. When the sinterability curve cannot be adapted and powder quality and lubrication conditions are fixed, the possibility still exists of minimizing irregularities in sintered diameter by using a single-action press and compacting the powder in an adapted conical die with a moving lower punch. (auth)

9920 MOLYBDENUM EFFECTS ON PROPERTIES OF TiC–Ni CERMET HARD ALLOYS. Samsonov, G. V.; Dzodziev, G. T.; Klyachko, L. I.; Vitryanyuk, V. K. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 57-60 (Apr 1972). (In Russian).

The effects of alloying hard alloys TiC–Ni with molybdenum within a wide concentration range on their structure and physicomechanical properties were studied. It was established that optimal properties are obtained at 20% Mo by volume in a bond and depending on the total content of the bond bending strength of the alloys changes from 105 to 180 kg mm^2 with hardness from 92 to 85 HRA, respectively. (auth)

9921 PHASE EQUILIBRIA IN HAFNIUM–NIOBIUM–BORON AND TANTALUM–CHROMIUM–BORON SYSTEMS. Kuz'ma, Yu. B.; Telegus, V. S.; Marko, M. A. (Lvov State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 66-71(A r 1972). (In Russian).

The Hf–Nb–B and Ta–Cr–B systems were investigated by means of x-ray and microscopic analyses and the phase equilibria at 1400°C were established. The continuous solid solutions HfB_2–NbB_2 were found to exist. The solubility of Hf in NbB was 20 at. %, in Nb_3B_4–5 at. %. The phase Ta_3B_2 dissolved 20 at. % Cr (a = 5.907, c = 3.233, c/a = 0.547 Å), the phase TaB–5 at. % Cr. The compound (A-phase) with the unknown structure was found within the Ta–Cr–B system. (auth)

9922 HOT PRESSING OF TRANSITION METAL NITRIDES AND THEIR PROPERTIES. Petrykina, R. Ya.; Shvedova, L. K. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 27-31(Apr 1972). (In Russian).

Compaction kinetics of transient metals of subgroups IV–VA of the periodic system and Cr_2N were investigated during sintering by hot pressing. Optimal conditions were established for sintering the nitrides by hot pressing and the values of the viscous flow process activation energy were determined during hot pressing. The Hall coefficient and resistivity of hot pressed nitrides of Ti, Zr, Hf, V, Nb, Ta were measured. (auth)

9923 PREPARATION AND SOME PROPERTIES OF CERMET MATERIALS OF THE SYSTEM AlN–Al_2O_3–Mo. Garibyan, F. S. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 44-8(Apr 1972). (In Russian).

The regime and conditions were developed to obtain materials of the system AlN–Al_2O_3–Mo. The best results as to density were obtained during sintering in a nitrogen medium at 1950°C for an hour with charging of roasted aluminum oxide. The porosity of samples obtained was 6 to 12%. Microstructure, microhardness, hardness, ultimate bending strength, and compression strength of the above-mentioned systems were investigated. (auth)

9924 PHYSICAL PROPERTIES OF W–Y_2O_3. Peletskii, V. E.; Druzhinin, V. P. (Inst. of High Temperatures, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 79-82(Apr 1972). (In Russian).

The radiative ability and the specific electric conductivity of cermets of W–Y_2O_3 were studied. The resistance was measured at 1300 to 2300°K on samples with 0.9 to 2.3% of oxide phase, and the dependence of resistance on oxide concentration is discussed. The integral hemispherical emissive ability was measured for the composition W–2.3% Y_2O_3 in the region 1200 to 3200°K. The emissive capacity of oxide occlusions was evaluated and related to the degree of blackness of cermets of the given type as compared to other oxide contents. (tr-auth)

9925 CREEP OF CaO-STABILIZED ZrO_2. St-Jacques, R. G.; Angers, R. (Univ. Laval, Quebec). J. Amer. Ceram. Soc.; 55: No. 11, 571-4(Nov 1972).

The compressive creep of 18 mol% CaO-stabilized ZrO_2 was studied at 1200 to 1400°C and 500 to 4000 psi. The specimens were polycrystalline with grain diameters from 7 to 29 μm. The activation energy for creep is 94 kcal/mol, and the creep rates are linearly proportional to the stress and to the inverse of the grain size. These results lead to the conclusion that creep in 18 mol% CaO-stabilized ZrO_2 may be controlled by cation diffusion associated with grain-boundary sliding. (auth)

9926 EQUILIBRIA OF SiF_4 WITH SiO_2, Be_2SiO_4, AND BeO IN MOLTEN Li_2BeF_4. Bamberger, C. E.; Baes, C. F. Jr. (Oak Ridge National Lab., TN). J. Amer. Ceram. Soc.; 55: No. 11, 564-8(Nov 1972).

Equilibrium partial pressures of SiF_4 were measured for the reactions $2SiO_2(c) + 2BeF_2(d) \rightleftharpoons SiF_4(g) + Be_2SiO_4(c)$ ($\log P_{SiF_4}$ (mm) = [8.790 – 7620/T] ± 0.06(500 to 640°C)) and $Be_2SiO_4(c) + 2BeF_2(d) \rightleftharpoons SiF_4(g) + 4BeO(c)$ ($\log P_{SiF_4}$ (mm) = [9.530 – 9400/T] ± 0.04 (700 to 780°C)), wherein BeF_2 was present in solution with LiF as molten Li_2BeF_4. The solubility of SiF_4 was low (≈0.04 mol kg^{-1} atm^{-1}) in the melt. The results for the first equilibrium were combined with available thermochemical data to calculate improved ΔH^f and ΔG^f values for phenacite (–497.57 ± 2.2 and –470.22 ± 2.2 kcal, respectively, at 298°K). The few measurements above 700°C for the second equilibrium are consistent with the temperature of the subsolidus decomposition of phenacite to BeO and SiO_2 and with the heat of this decomposition as determined by Holm and Kleppa. Below 700°C, the pressures of SiF_4 generated showed an increasing positive deviation from the expression given for the equilibrium involving Be_2SiO_4 and BeO. This deviation might have been caused by the formation of an unidentified phase below 700°C which replaced the BeO; it more likely resulted from a metastable equilibrium involving BeO and SiO_2. (auth)

9927 THERMODYNAMIC PROPERTIES OF THE SYSTEM INDIUM–OXYGEN. Chatterji, D.; Vest, R. W. (Purdue Univ., Lafayette, IN). J. Amer. Ceram. Soc.; 55: No. 11, 575-8(Nov 1972).

The free-energy change for the reaction $2In(l) + 3NiO(s) = In_2O_3(s) + 3Ni(s)$ was determined from 550° to 800°C from emf measurements on solid-oxide galvanic cells. The results were used to develop an equation for the standard molar free energy of formation of In_2O_3, i.e., $\Delta G^\circ_{In_2O_3} = -215{,}550 + 72.63T \pm 450$ cal/mol. The standard molar enthalpy and entropy of formation of In_2O_3 at 298°K were calculated to be –214,000 ± 1500 cal/mol and –69.03 ± 0.22 eu, respectively, using the available thermochemical data. The absolute entropy of In_2O_3 at 298°K was calculated to be 32.23 ± 0.22 eu. The free-energy results of this study were used in conjunction with literature data to calculate partial pressures of the gaseous species over In_2O_3 for different experimental conditions. (auth)

9928 URANIUM DIOXIDE–YTTRIUM OXIDE–ZIRCONIUM DIOXIDE MICROSPHERES. Smith, J. G.; Fitch, F. T. (to

W. R. Grace and Co.). U. S. Patent 3,697,435. 10 Oct 1972. Filed 16 Mar 1967.

A method is described for the production of microspheres containing 30 to 55% UO_2, 10 to 45% Y_2O_3, and 15 to 55% ZrO_2. The microspheres with a size of 50 to 400 microns are formed by the general technique of mixing an ammonia-releasing agent with an aquasol of the metal oxides, introducing the mixture in the form of droplets into a dehydrating solvent having a temperature that is sufficiently high to cause substantial ammonia release from the ammonia-releasing agent, and recovering from the dehydrating solvent microspheres that have undergone at least partial dehydration. (P.C.H.)

9929 CHEMICAL VAPOR DEPOSITION OF GRAPHITE AND BORON NITRIDE ON TUBULAR REACTOR WALLS AT ELEVATED TEMPERATURES. Elsaiedy, A. A. Lexington, KY; Univ. of Kentucky (1972). 224p. University Microfilms Order No. 72-29,270.

Thesis.

A tubular reactor system was designed, built, and operated to study chemical vapor deposition. Deposition took place on the inner reactor surface over a twelve inch length which was maintained at a constant temperature. For the deposition of carbon, methane in helium was used at concentrations ranging from 16.7 to 45.4% methane over a temperature range of 1200 to 2035°C. The total mass flow rate ranged from 3.3 to 9.1 g/cm^2-sec. The deposit thickness was measured as a function of axial position, using a micrometer. Except for the runs in excess of 2000°C which resulted in low density deposits that filled the tube the thickness displayed a maximum with axial distance. The ratio of the maximum thickness/average thickness varied from 3.2 (27.8% CH_4, 1400°C) to 6.2 (28.6% CH_4, 1600°C). Deposit density was measured by the sink-float method and the highest value was 91% theoretical obtained at 40.7% CH_4 and 1400°C. Density was found to go through a minimum for the 1400°C runs at a methane composition of 27.8%. Conversion of methane to the pyrolytic carbon deposit went through a maximum of 46% conversion at 1400°C and 27.8% CH_4. At high methane concentration (45.4%) low conversions (about 30%) were found at 1200, 1400, and 1600°C. The point source diffusion model was used to calculate methane concentration as a function of axial position. These values together with a first-order rate constant available in the literature predicted a thickness-distance relationship in good agreement with the measured values. Pyrolytic boron nitride was deposited as a rodlike structure in the direction of flow at 2170°C using a BF_3-NH_3 mixture at about 102 torr. Continuous deposits were not produced over the reactor length in appreciable thickness for the conditions attempted. A white, fluffy, water-soluble powder was formed at room temperature from reaction of both BF_3 or BCl_3 with NH_3. In the latter case the resultant material was thought to be a mixture of NH_4Cl, $H_3N \cdot BX_3$, $(HBNH)_n$, and $(BN)_x$. (Diss. Abstr. Int., B)

9930 U.K. VIEW OF FUEL DENSIFICATION AND CLAD STABILITY IN OXIDE FUEL PINS. Locke, D. H. (United Kingdom Atomic Energy Authority Reactor Group, Springfields, Eng.). Nucl. Eng. Int.; 17: No. 199, 1015-17(Dec 1972).

The Reactor Fuel Element Laboratories have studied nuclear fuel densification and cladding stability for several years. Numerous models of fuel pin performance have been developed which show good agreement with the data obtained at Windscale during post-irradiation examination of UK fuel elements. These programs provide acceptable explanations of the fuel performance phenomena recently reported for water reactors and show how the phenomena can be related to the reactor environment. The processes involved overlap but for clarity in presentation they are dealt with sequentially. The post-irradiation examination of low-density fuel has shown that in-reactor fuel densification can be controlled by varying the manufacturing process. (auth)

9931 MATERIAL COMPOSED OF NUCLEAR FUEL AND EXPANDED GRAPHITE. Slonina, Jean-Pierre; Maire, Jacques; Pernollet, Andre (to Le Carbone-Lorraine SA). French Patent 2,085,312. 24 Dec 1971. Filed 8 Apr 1970. (In French).

An improvement to materials previously developed for nuclear reactors is described. The reactors considered are of the type incorporating an agglomeration of nuclear fuel particles in recompressed expanded graphite, either in the form of supple layers or bulk material formed by the superposition of layers capable of being agglomerated by a carbonizable bonding material. An improved material is obtained enabling a greater homogeneity to be obtained for the nuclear fuel particles; this material can be used to fill the elements (of any shape) of nuclear reactors, e.g., cylindrical elements, ringed elements, prismatic elements etc. The material has improved elastic properties. The nuclear fuel particles are regularly distributed between two or several layers of expanded graphite, the particles being distributed either singly, or in groups. The layers loaded in this way are then compressed or laminated in the form of supple layers. (France)

9932 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL COMPACTS OF COATED PARTICLE FUEL. Sturge, Derek William James; Gough, John Richard Cox (to United Kingdom Atomic Energy Authority). British Patent 1,282,454. 19 Jul 1972. Filed 11 Jul 1969.

Reference is made to processes for making coated particle nuclear fuel containing bodies by pressing, without a risk of cracking of the coatings. In the process described, an overcoating of firm matrix material is applied to the fuel particles. The bonding agent of the matrix material is in an unpolymerised condition and the thickness applied is such as to give, on pressing, a body of the required fuel content for unit volume of the body. The particles are die pressed, with a layer of the matrix material containing unpolymerised bonding agent, against surfaces of the cavity; heating is applied during pressing to melt the bonding agent and is continued so as to effect polymerisation. A layer of nuclear fuel particles overcoated with matrix material to a thickness greater than that required for the requisite volume loading may also be placed adjacent to the surface of the die. Alternatively, a layer of microspheres composed of matrix material and unpolymerised bonding agent may be placed adjacent to the die surface, or a matrix powder may be employed. (UK)

9933 TECHNOLOGY OF CERMETS. Nazare, S.; Ondracek, G.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). High Temp. - High Pressures; 3: No. 6, 615-34(1971). (In German).

A definition of a cermet is stated and fields of application for such materials are pointed out. The reasons for the predominance of powder metallurgical methods in their preparation are given. With reference to the various preparation steps (e.g., powder characterisation, combination or aggregation of the components, compaction and forming) the special features which are technologically specific to cermets are discussed, particularly those that influence the behavior at the interface between the metal and ceramic particles in the powder or compact. Thus the particle size and shape affect the integral interface area and therefore influence the densification during compaction and sintering. Low amounts of alloying additions in one of the cermet components can have a decisive effect on the stability of the combination as well on the bonding at the interface. This bonding can be improved by thin "auxiliary" coatings on the particles. The various methods of combining the components are discussed, and it is shown that a good distribution and idealized structure can be obtained even when the ceramic content is high. The dependence of the density on compacting pressure and on metal-ceramic ratio is considered and the effect of friction between metal and ceramic particles in relation to the friction between metal and metal, and ceramic and ceramic particles is discussed. Some aspects of sintering are considered including the selection of temperature and protective atmosphere, sintering under pressure, and the formation of microcracks on cooling. Methods of preparation of cermets by directional solidification are also mentioned. The combination of densification and shaping in a single step is discussed with reference to the picture-frame-technique (for 1-3 mm thick plate-type nuclear fuel elements) and coextrusion (for 5 mm diameter rod-type UO_2- stainless steel dispersion fuel elements). (auth)

9934 GROWTH OF INERT-GAS BUBBLES IN SOLIDS. BEHAVIOUR OF NON-UNIFORM SIZE DISTRIBUTIONS. Markworth, A. J. (Battelle Memorial Inst., Columbus, OH). J. Mater. Sci.; 7: No. 11, 1225-8(Nov 1972).

An analytical study of the effects of non-uniform sizes on the growth kinetics of inert-gas bubbles in solids is presented. Assuming ideal-gas behavior and gas-diffusion-controlled growth, it is found that for out-of-reactor conditions, the size distribution undergoes pure translation in bubble-radius space, the growth kinetics being independent of the details of the size-distribution function. On the other hand, for in-reactor growth in fissile materials, it is found that kinetic re-solution of fission gas causes any arbitrary subset of the overall size distribution to become increasingly "narrow" as bubble growth proceeds, as long as all bubbles within the subset are described by the same given kinetic behavior. (auth)

9935 DIMENSIONAL AND MICROSTRUCTURAL ANALYSIS OF COEXTRUDED UO_2-STAINLESS STEEL CERMET PINS. Nazare, S.; Ondracek, G.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). Powder Met.; 15: No. 30, 314-31(1972).

Coextrusion has been used to prepare UO_2 (35 vol %)-stainless steel cermet fuel-pins (5.6 mm dia × 1000 mm long), which could

be used as fuel elements in fast-flux test reactors. The procedure requiring a nearly homogeneous distribution of the fissile phase in the matrix is described. The influence of billet design on the dimensions of the fuel core and cladding is analyzed with a view to its optimization. The extent of particle deformation as a function of extrusion parameters has been measured quantitatively by means of image analysis on particles having different (12.7%; 5.8%) inner porosities. Thermal expansion and conductivity as well as tensile strength of the cermets are reported and compared with existing data. (auth)

9936 CRYSTALLOGRAPHIC SHEAR AND ORDERED REDUCTION OF UO_2. Matzke, H.; Ronchi, C. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). Phil. Mag.; 26: No. 6, 1395-1407(Dec 1972).

Electron microscopy was used to study the surfaces (with replicas) and the near surface regions (with transmission) of UO_2 annealed under reducing conditions. Parallel striations were observed with both techniques following isothermal or pulse annealing to temperatures between 1480 and 1950°C, and simultaneously a splitting of the spots in the diffraction patterns occurred. These observations are consistent with the formation of planar faults in a crystallographic shear structure of partly reduced UO_2. A reduction to $UO_{1.98}$ is indicated for regions near the surface on annealing UO_2 to 1500°C in H_2. The surface structure is probably related to additional etching to minimize the misfit. Implications of the ordered reduction on physical measurements sensitive to surface conditions (especially of uranium self-diffusion), and on the understanding of the defect structure of UO_2, are discussed. (UK)

9937 METHOD OF PRODUCING AN YTTRIUM OXIDE BODY. (to Hitachi Ltd.). British Patent 1,291,360. 4 Oct 1972. Priority date 21 Nov 1969, Japan.

A method is described for producing very dense and pure sintered polycrystalline Y_2O_3 bodies. It involves press molding grains of oxide of not less than 99.9% purity under a molding pressure between 1 and 30 tons/cm^2, to form a body of desired shape, and then sintering the molded body in a non-oxidizing atmosphere at 2,150 to 2,330°C for not less than 30 min. The method is based on the finding that removal of pores from the oxide grains is greatly facilitated by the foregoing procedure. Sintering should preferably be carried out in a dry H_2 atmosphere. The product obtained is deep brown to black in color; if decolorization is required the product should be refined in a slightly wet H_2 atmosphere. The density of the product is not less than 98% theoretical. (UK)

9938 PARTICLE GROWTH AND CREEP BEHAVIOR OF HIGHLY DISPERSED UO_2/Mo CERMETS IN THE TEMPERATURE RANGE OF 1450 TO 2000°C. Huebner, H. Erlangen, Ger.; Erlangen Univ. (1971). 71p. (In German).

Thesis.

The structure changes and creep behavior at temperatures between 1450 and 2000°C were investigated for UO_2/Mo cermets with various prepared samples and parts of the ceramic of 30 and 50 vol. %. (GF)

Metals and Alloys

Refer also to abstract 11485.

9939 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. September 1972. Band 6, Heft 9. 209 Referate (Register-Nr.2556-2918); 62 Referate (Register-No.627 T-688 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. September 1972. Vol. 6, No. 9. 209 Abstracts (Register No. 2556-2918); 62 Abstracts (Register No. 627 T-688 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H. (1972). 127p. (In German and English).

9940 TANTALUM AS A MERCURY CONTAINMENT MATERIAL IN MERCURY RANKINE-CYCLE SYSTEM BOILERS. Derow, H. (Aerojet Nuclear Systems Co., Azusa, CA); Stone, P. L. pp 11.18-23 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Two candidate boiler designs for the SNAP-8 system, both utilizing unalloyed tantalum (Ta) as the mercury containment materials, are discussed. The results of loop tests with several Ta boiler test sections and operation of two full scale boilers are presented. Data from unalloyed Ta mechanical properties testing, in support of the SNAP-8 boiler program, are given. The fabrication of Ta/316 SS bimetallic tubing and Ta/316 SS transition joints is described. As a result of the above testing programs, it is concluded that Ta is capable of providing the SNAP-8 minimum required service life of 5 years. (auth)

Corrosion and Erosion

Refer also to abstract 11522.

9941 (TRW(A)-11069-68) DEVELOPMENT OF A HIGH-TEMPERATURE VENTED RADIOISOTOPE CAPSULE. VOLUME 3. PRELIMINARY COMPATIBILITY TESTING OF CANDIDATE VENT AND CAPSULE MATERIALS. Final Summary Report. (TRW Systems Group, Redondo Beach, Calif.). Aug 1972. Contract AT(29-2)-2551. 85p. Dep. NTIS.

Results of compatibility testing of candidate materials for use in high-temperature vented radioisotope fuel capsules are presented. Forty-six experiments were performed at 1600 to 2600°F and exposure times of 3 to 30 days. Materials involved in the experiments included Ta, Ta-W alloy, T-111 alloys, Mo, TZM alloy, Pt, Pt-Rh alloy, Al_2O_3, and Y_2O_3. (J.R.D.)

9942 BEHAVIOR OF PROTECTIVE METAL COATINGS IN FRESH WATER. Pavlova, F. S.; Gerasimov, V. V., Ermolova, T. A. Zashch. Metal.; 6, No. 5, 622-5(1970). (In Russian). (In Russian).

The behavior of Cd, Cr, and Ni coatings was studied over 8000 to 17000 hours in a solution containing NaCl 160 mg/l, H_2SO_4 (sp gr 1.83) 200 mg/l and $NaHCO_3$ 140 mg/l at pH 6.3 and with natural aeration. (Referativnyi Zh.)

9943 COMPARATIVE CORROSION TESTING OF ZINC AND CADMIUM COATINGS. Kudryavtseva, I. D.; Lipkina, L. A.; Skalozubov, M. F.; Yurinskaya, L. V. Zashch. Metal.; 7: No. 1, 63-6(1971). (In Russian).

The comparative corrosion resistance was determined for bright and dull, passivated and non-passivated Zn (10 to 30μ) and Cd (10 to 15μ) coatings, also 5-5, 10-5, and 15-5 μm two-layer bright Zn, dull Zn and Zn-Cd coatings. Coatings were applied from ammine and amine-urotropin electrolytes, also sulfate electrolytes (cadmium). Tests were carried out in simulated tropical conditions in a TVK-2A chamber, and also by periodic dipping and complete immersion in 3% NaCl. Corrosion resistance was evaluated visually, from the presence of spots and corrosion products from coating and substrate. All chromated dull and bright Zn and Cd coatings, also phosphated Zn coatings, gave good results in humidity chamber tests. Zn-Cd coatings of all thicknesses maintained a good appearance in the same conditions. Non-passivated Zn and Cd coatings were damaged in all tests. In 3% NaCl, Zn-Cd coatings were less resistant than single coatings and suffered pitting. Bright Zn coatings were more resistant than dull, and possessed better protective properties. Two-layer Zn coatings showed good resistance. (Referativnyi Zh.)

9944 INFLUENCE OF OXIDANTS ON THE CORROSION AND ELECTROCHEMICAL BEHAVIOR OF NICKEL-MOLYBDENUM ALLOY EP-496 IN HYDROCHLORIC ACID. Kashcheeva, T. P.; Dubikhina, V. S.; Gadasina, L. Yu.; Meshcheryakova, I. D.; Rutkovskii, M. L. Zashch. Metal.; 7: No. 1, 11-15(1971). (In Russian).

A study was made of the influence of O_2 and Fe^{3+} ions on the corrosion and electrochemical behavior of alloy EP-496 in 22% HCl at 20 and 100°C. Alloy corrosion rate was found to be determined by the concentration of depolarizer and by its rate of supply to the corroding surface. (Referativnyi Zh.)

9945 OXIDATION OF FINITE SAMPLES OF HEAT-RESISTANT ALLOYS. Whittle, D. P. (Univ. of Liverpool). Corros. Sci.; 12: No. 11, 869-72(Nov 1972).

The kinetics of the oxidation of samples of heat-resistant alloys are considered, where the thickness of the sample is comparable to the depth of oxidation. The protective mechanism of a continuous layer of Al_2O_3 or Cr_2O_3, formed through selective oxidation of an alloy, is referred to. It is stated that the alloy must contain sufficient of the element being selectively removed (for example A in a binary alloy AB) so that the concentration of A at the alloy-oxide interface remains above that for thermodynamic stability of the oxide AO_γ in contact with the alloy. When oxidation experiments are carried out, if the samples are so thin that the A-depleted zones from either side ultimately meet in the center, the concentration of A at the alloy-scale interface will decrease. So-called chemical breakdown occurs, at a time which can be estimated by considering the appropriate diffusion equations. As a particular example, the oxidation of a thin sample of Ni-20 wt.% Cr at 1200°C is discussed in detail. (UK)

9946 ELLIPSOMETRIC DATA ANALYSIS OF THE OXIDATION OF THIN MOLYBDENUM FILMS. Lederich, R. J. (McDonnell Douglas Corp., St. Louis). J. Opt. Soc. Amer.; 62: No. 12, 1524-5(Dec 1972).

A method of data analysis for use in experiments involving metal oxidation kinetics in which the analysis is complicated by opacity of the metal and oxide films is described. Ellipsometric parameters related to both films are incorporated in plots and used in determination of the kinetics of oxidation. (J.R.D.)

9947 CORROSION OF ZIRCALOY-2 COOLED FROM β PHASE TEMPERATURE WITH DIFFERENT COOLING RATES, IN HOT WATER AND STEAM ENVIRONMENT. Ueki, Ichiro; Kagawa, Masaru; Akiyama, Hiroaki. (Nippon Genshiryoku Gakkaishi; 14: No. 11, 589-96(Nov 1972). (In Japanese).

Specimens of Zircaloy-2 were immersed in water at 360°C under 190 kg/cm^2 and in steam at 400°C under 100 kg/cm^2 up to 175 days, and their behavior was examined by weight gain measurements and metallographic examination. In the case of as-cooled Zircaloy, the effects of differences in cooling rate on the corrosion weight gain were found only in the early stages of steam corrosion, and this was attributed to blistering of the oxide films found between the grain boundaries on the surfaces of the alloy. Preferential oxidation of grain boundaries was found on as-cooled specimens corroded in water, and this was attributed to galvanic-type corrosion accelerated by local dilution of the solute elements around the precipitates on the grain boundaries. The Breakaway phenomena in Zircaloy corrosion kinetics are explained in terms of the mechanical detachment of the protective oxide films from the alloy surfaces by stresses which arise during film growth, and rapid propagation of this cleavage favored by the change occasioned on the microstructure of the oxide films. Among the alloying elements of Zircaloy-2, Fe, Cr, and Ni were found to precipitate with Zr as intermetallic compounds, thus forming discontinuities on the oxide film, and these elements consequently contribute to relieving the stresses and to improving the corrosion resistance of the alloy. (auth)

9948 SNAP-8 POWER CONVERSION SYSTEM, BREADBOARD ASSEMBLY: MATERIALS EVALUATION AFTER 8700 HOURS OPERATION. Derow, H. (Aerojet Nuclear Systems Co., Azusa, CA). pp 11.24-7 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The SNAP-8 Power Conversion System Breadboard Assembly, designated PCS-1, completed an 8700 hour test using prototype components and liquid metal containment materials. The test included two runs of continuous self-sustained operation, each exceeding 2000 hours duration. Materials evaluation was conducted during and after these tests in order to obtain data with which to extrapolate the life potential of the SNAP-8 flight system for space power applications. The results of these evaluations are described and their salient characteristics are discussed. (auth)

9949 EROSION OF A THREE-STAGE POTASSIUM TURBINE. Kaplan, G. M. (Lewis Research Center, Cleveland); Schnetzer, E. pp 11.80-7 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The effort on potassium vapor turbines began in 1961. Initially, a two-stage turbine was tested for 5000 hours with a vapor exit quality of about 92 percent. A recently completed 5000-hour endurance test with a three-stage turbine extended this experience to a vapor exit quality of about 87 percent, comparable to current nuclear steam plant practice. Turbine rotor blade overall damage was small and indicated a potential life many times the actual 5000 hours of testing. The third-stage inlet vapor quality during the initial 4300 hours of testing was 93 percent or less (91 percent) and the exit quality was 87 percent or less for the same period. The Rene-77 third-stage rotor blades experienced an average weight loss of 0.046 gram corresponding to a volume loss of 0.005 cm^3. Material removal occurred only at the leading edge. The maximum removal noted was approximately 2 mils near the dovetail platform extending to about 11 mils near the top of the leading edge to about 27 mils within the last 1 percent of the airfoil height. Impact damage is visible at the blade tip. Material removal from the molybdenum-base TZM and TZC third-stage rotor blades was atypical and is attributed mainly to corrosion from the oxygen contamination of the potassium system. Material loss occurred at the leading edges, suction surfaces, and trailing edges of the blades. The material removal from the leading edges tended to be an almost uniform 21 mils from the dovetail platform toward the blade tip. At about 60 mils from the tip (95 percent of airfoil height), the leading edge profile receded a maximum of 59 mils. The weight loss experienced by a typical TZM and TZC blade was 0.913 and 0.905 gram, respectively, corresponding to volume losses of 0.090 and 0.089 cm^3, respectively. Since the Rene-77 is known to be less resistant to erosion than TZM and the molybdenum damage is predominately due to corrosion, the lack of significant material removal from the Rene-77 is considered representative of the endurance capability of a potassium turbine with 87 percent exit vapor quality. (auth)

9950 HARDNESS AND CORROSION RESISTANCE OF NICKEL ALLOYS WITH MOLYBDENUM AND TUNGSTEN. Nikandrova, E. A.; Ivanov, A. G. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 3-4, 210-12(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 3, 24-7(Mar 1972).

The newly-developed Ni–Mo–W corrosion resistant hard alloys (N65M20V15 and N55M20V25) have a corrosion rate of no more than 0.2 mm/year in 30% HCl at 60°C and in 70% H_2SO_4 at 90°C, with a hardness as high as HRC 52. The alloys are precipitation-hardening. To obtain a high hardness it is recommended that they be heat treated by water quenching from 1000-1050°C and aging at 800°C for 4 h. (auth)

9951 CORROSION PROPERTIES OF ALLOY N70M27 AFTER ORDERING. Kirienko, V. I.; Svistunova, T. V.; Potapov, L. P.; Runova, Z. K. (Central Scientific-Research Inst. of Ferrous Metallurgy, Moscow). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 3-4, 205-9(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 3, 19-24(Mar 1972).

The relationship between the corrosion resistance of alloy N70M27 and the phase composition as well as the shape and size of antiphase domains of Ni_4Mo that is precipitated during isothermal annealing at 700 and 800°C was investigated. The corrosion tests were made in boiling 21% HCl for 240 h. The general corrosion resistance and resistance to intercrystalline corrosion are highest for the alloy with an unordered solid solution. The development of ordering processes at 500 to 800°C lowers the corrosion resistance. The decrease of the resistance depends on the number, shape, and size of Ni_4Mo domains. (T.F.D.)

9952 STUDY OF NICKEL PASSIVITY BY NUCLEAR MICROANALYSIS OF ^{16}O AND ^{18}O ISOTOPES. Siejka, J.; Cherki, C.; Yahalom, J. (Ecole Normale Superieure, Paris). Electrochim. Acta; 17: No. 12, 2371-80(Dec 1972).

The passivity of nickel in 1 NH_2SO_4 was investigated by using a nuclear microanalysis technique for the determination of ^{16}O and ^{18}O isotopes on the metal surface. It was established by ^{18}O tracing that the first monolayer of oxygen has a marked effect on the passivity of the metal. Further thickening of the film up to a maximum of about 5 monolayers seems to control the anodic current by an ion-transfer mechanism. The total quantity of oxygen found on the samples after their removal from the solution is independent of the polarization potential due probably to further oxidation in the atmosphere. (auth)

Preparation and Fabrication

Refer also to abstract 9802.

9953 (KAPL-P-3954) RELATING PERFORMANCE REQUIREMENTS OF THERMAL POWER GENERATING EQUIPMENT TO MEANINGFUL MATERIAL AND PROCESS SPECIFICATIONS. Fleischmann, W. L. (Knolls Atomic Power Lab., Schenectady, N. Y.). 1972. Contract W-31-109-Eng-52. 7p. (CONF-721024-3). Dep. NTIS.

From 32nd national conference of the American Society for Nondestructive Testing; Cleveland, OH. (16 Oct 1972).

Considerations involved in evaluating acceptability of welds in heavy-walled pressure vessels are reviewed. Illustrations are included concerning the interrelationships of requirements established by the use of heavy-section pressure vessel steel having specific properties with process standards, and the results of nondestructive testing. (J.R.D.)

9954 PERFECTION OF YTTRIUM MONOCRYSTALS. Esin, V. O.; Tagirova, D. M.; Chuprikov, G. E. Izv. Akad. Nauk SSSR, Metal.; No. 3, 106-10(1972). (In Russian).

Single crystals of Y were grown by crucible-less zone melting, and the rate of growth was correlated with the state of perfection of the resulting crystal, as judged by x-ray and metallographic studies. Induction heating with a frequency of 5.2 MHz in a vac-

uum was used in connection with Y, which had a purity of 99.93%. (K.S.W.)

9955 SEPARATION OF SAMARIUM AND EUROPIUM FROM EGYPTIAN MONAZITE SANDS BY SODIUM AMALGAM. PART I. Farah, M. Y.; Saleh, F. A.; Moustafa, M. (Egyptian Atomic Energy Establishment, Cairo). Z. Anorg. Allg. Chem.; 392: No. 1, 69-80(Aug 1972).

Factors affecting the separation of both Sm and Eu from other rare earths, after acid processing of monazite, by sodium amalgam are: increasing extraction in the order Sm > Eu > La at all pH values, preferably at pH 3.5 with an enrichment ratio of 14 : 9 : 1; 0.26% sodium amalgam giving optimal results, preferably on cooling nearer to zero temperature. The pollution by La of separated Sm or Eu could be masked by sodium chloride addition in up to 0.2 N. Buffering by acetate was proved to be indispensable and preferentially in no less than 64 ml glacial acetic acid/l feed. Concerning the total lanthanons concentration, a 35 gm/l feed is recommended. When working on alkali by-produced rare earths liquors, good enhancement in both recoveries and purity was achieved by use of dodecylamine dispersed sodium amalgam. (auth)

9956 CO-EXTRUDED BERYLLIUM/TITANIUM ALLOY COMPOSITES FOR LIGHT WEIGHT STRUCTURES. London, G. J.; Taylor, W.; Herman, M. pp 69-79 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Composites containing beryllium fibers in a Ti-6Al-4V alloy matrix were produced by a co-extrusion technique. The beryllium reinforcement increased specific modulus while retaining adequate strength for structural applications. Initial extrusions exhibited poor Be/Ti bonding. Improved billet preparation and extrusion techniques produced well-bonded material. Sheet 0.030 to 0.060 in. thick was produced by hot rolling an extruded flat configuration. Ultrasonic inspection of the composite sheet material was performed. Good sheet modulus and tensile and fatigue properties were obtained. (auth)

9957 PRODUCTION OF DISPERSION STRENGTHENED NICKEL-CHROMIUM ALLOYS. Klingler, Leo J.; Weinberger, William R. (Fansteel Inc., Baltimore). pp 201-19 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Process and scale-up developments for TD-Nickel Chromium mill products are described, and the current capabilities are presented. Development of a new alloy, TD-Nickel Chromium Aluminum, is described; the alloy has improved oxidation behavior over that of the base TD-Nickel Chromium. (auth)

9958 CURRENT COLUMBIUM ALLOY PROCESSING TECHNOLOGY. Schussler, M. (Fansteel Inc., Baltimore). pp 223-42 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The current technology for processing Nb-base alloys from ores to finished fabricated parts is reviewed. Precautions that are taken in the various process steps are emphasized to point out how high quality is achieved and maintained in Nb alloy fabrications. (auth)

9959 FABRICATION METHODS FOR TD NICKEL. Leach, Almon E. (Bell Aerospace Co., Buffalo). pp 315-26 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Spin-forming, welding, machining, electric discharge machining, and electroforming operations in the construction of a TD-Nickel rocket thrust chamber are described. TD-Nickel was one of the first commercially available dispersion hardened alloys. Dispersion hardened alloys are being given prominent consideration in the construction of the space shuttle; therefore, fabrication experience gained with the TD-Nickel material is of current interest. (auth)

9960 DEPOSIT OF MOLYBDENUM COATINGS BY A CURRENT OF ALTERNATING POLARITY. Baraboshkin, A. N.; Shunailov, A. F.; Martem'yanova, Z. S. Tr. Inst. Elektrokhim., Akad. Nauk SSSR, Ural. Filial; No. 16, 67-77(1970). (In Russian).

Equations for the micro-distribution of current in the cathodic deposition and the anodic dissolution of metal are presented for a complex electrolyte. The use of current of alternating polarity provides a smoothing effect in the electrolyses of complex solutions when the ion-to-metal discharge is hindered. The theoretical expectations were confirmed in the example of the electrolysis of Mo using a Mo anode and a molten electrolyte which was chiefly $CaCl_2$ and $CaMoO_4$. With limited diffusion current of free oxygen ions, electropolishing of the Mo surface occurred. Smooth, even deposits of Mo of one mm thickness and greater could be obtained. (tr-auth)

9961 DRILLING IN THE PRESENCE OF LIQUID METALS. Shchukin, E. D.; Polukarova, Z. M.; Yushchenko, V. S.; Bryukhanova, L. S. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 205: No. 1, 86-9(1 Jul 1972). (In Russian).

The decrease in hardness of solid metals and alloys was studied when in contact with liquid metals under specified severe conditions. The ease of drilling (drill feed rate at constant pressure) of Cu, Al, various steels, and stainless steel was evaluated when performed in the dry state and in the presence of the following liquids: vaseline, kerosine, oleic acid, In, Ga, Sn, and the eutectics of the In-Ga-Sn system, Sn-Zn system, Sn-Pb system, and Wood's alloy. The facilitation of drilling which resulted in most cases is discussed. (K.S.W.)

9962 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Garlick, A. (to United Kingdom Atomic Energy Authority). British Patent 1,288,267. 6 Sep 1972. Filed 4 Jun 1969.

In water reactors the fuel sheaths are normally formed of Zr alloys, such as the Zircaloys, and it has been found that under certain conditions they may be liable to failure as a result of stress corrosion cracking. A treatment is described that increases the endurance; this involves annealing in the alpha phase to partially remove cold work. The temperature should be at least 650°C for at least one hour. In this way the yield stress is lowered below the threshold stress for crack propagation and the material yields in a ductile manner. The treatment is most effective with sheaths produced by tube reduction, but there is also some improvement with cold drawing. (UK)

9963 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENT SHEATHS. Lindsay, William Owen (to United Kingdom Atomic Energy Authority). British Patent 1,285,883. 16 Aug 1972. Filed 18 Oct 1968.

There is a requirement, particularly in gas-cooled reactors, for thin-walled tubular sheaths with small stubby circumferential fins spaced apart by several fin thicknesses along the length of the sheath. Typical dimensions of such a sheath made of austenitic stainless steel are 42-in. length, ⅝-in. diameter, and about 0.015-in. wall thickness, with about 0.01-in. square section fins at 0.080-in. pitch. The fins may be individual or consist of a continuous helix of the requisite pitch. The only methods that have so far proved practical for meeting the required high specification standard involve slow and costly grinding or milling the fin pattern out of comparatively thick walled tube, and it has been found very difficult to control the wall thickness within the required tolerance. In the manufacturing method described, a helical groove is cut in the wall of a tube by means of thread cutting dies that cut a groove the depth of which corresponds to the desired fin height, the width being greater than the depth, and the helix exceeding the width of the groove by the desired fin thickness. Suitable dies are described. Si-loaded mineral oil is preferably used as lubricant. (UK)

9964 APPLICATION OF CHROMIUM-BASE ALLOY POWDERS TO WELDING OF HIGH-ALLOY STEELS. Borok, B. A.; Shchegoleva, R. P.; Golubeva, L. S.; Rabinovich, E. M. Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 98-100(Apr 1972). (In Russian).

Compositions were investigated and experimental batches of powdery alloys in a chromium base were obtained. The alloys were designed for construction welding, and some contained a few percent of Ti, 12% Mo, and/or 4% Nb. Chromium base powders can be used with high technical and economical efficiency for electrode coatings for production of wire and for automatic welding of plating layers of two-ply steel. (auth)

9965 ALKALI METAL PURIFICATION AND HANDLING FOR ADVANCED SPACE POWER SYSTEMS. Hand, R. B. (General Electric Co., Cincinnati). pp 11.1-6 of Energy 70, Proceedings, Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The techniques and procedures used to purify, analyze, sample and transfer lithium, potassium, and NaK for use in refractory metal systems are described. The quality of the product delivered

to such systems is given. In order to avoid the deleterious effects of contaminants, the philosophy has been to use ultrapure alkali metals in systems of exceptional cleanliness. The applicability of these techniques to actual space power systems is discussed. (auth)

9966 FABRICATION OF REFRACTORY ALLOY COMPONENTS FOR ADVANCED SPACE POWER SYSTEMS STUDIES. Young, W. R. (General Electric Co., Cincinnati). pp 11.7-11 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The development of advanced Rankine and Brayton Cycle power concepts has required the use of refractory alloys such as T-111 (Ta-8W-2Hf) and Cb-1Zr to meet system requirements. The joining technology developed to fabricate prototype components for high-temperature liquid metal and inert gas containment is described. (auth)

9967 NEW TECHNIQUE FOR METAL BONDING AND CLEANING. Christe, K. O.; Wilson, R. D.; Pilipovich, D. (Rocketdyne, Canoga Park, CA). Weld. J. (N. Y.); 51: No. 12, 599s-601s(Dec 1972).

A process is described for cleaning and joining metal surfaces. The process uses gaseous hydrazine, N_2H_4, as the active reducing agent or flux. The hydrazine catalytically decomposes on the metal oxide surface, thereby reducing the metal oxide to the metal with all reaction products being volatile gases. This process, when carried out in the presence of low melting metals or alloys, such as solder, results in excellent metal-to-metal bonds without producing nonvolatile, corrosive, or electrically conducting residues. The combination of a gaseous, noncorrosive, residue-free flux with relatively low working temperatures renders this process ideal for applications such as cleaning metal surfaces, diffusion bonding, soldering, or reflowing of electronic circuit boards, or of very small, inaccessible, or temperature-sensitive workpieces. The feasibility of this process is demonstrated for cleaning and reflowing printed copper circuit boards, for soldering copper to copper, or copper to gold using lead-tin solder, and for soldering inside the bore of beryllium-copper capillaries. (auth)

9968 ACTIVATED SINTERING OF TUNGSTEN. Kolar, D.; Jurca, S.; Trontelj, M. (Institut Jozef Stefan, Ljubljana, Yugoslovia). Rudarsko-Met. Zb.; 1: 39-45(1970).

A review of the literature on this problem is given, and opinions on the mechanism of activated sintering are summarized. All the opinions and theories have one common characteristic-that they are founded on a relatively meager experimental data. Therefore, some experiments with activated sintering were made to give a basis for further investigations. (Bull. Sci. Sect. A Sci. Nat. Tech. and Med.)

9969 PREPARATION OF A Ni-ThO_2 DISPERSED-PHASE ALLOY FROM ORGANOMETALLIC COMPOUNDS. Marty, M.; Walder, A.; Hivert, A. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). High Temp. - High Pressures; 3: No. 6, 677-85(1971). (In French).

The several steps of a method for preparing an Ni-ThO_2 alloy are described. The originality of the process rests in wetting a powdered nickel compound, in suspension within a methyl polymethacrylate, by a solution of a thorium salt, the pyrolysis of which gives at 550°C and above a stoichiometric thoria. The half-product, in the form of Ni-ThO_2 powder, is worked by extrusion. Thermomechanical treatment is required to ensure good mechanical properties at high temperature. (auth)

9970 PREPARATION OF Ni-Cr-ThO_2 ALLOYS BY DIFFUSING CHROMIUM INTO A Ni-ThO_2 GRANULE, USING A HALOGEN CARRIER. Marty, M.; Walder, A.; Galmiche, P.; Hivert, A. (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). High Temp. - High Pressures; 3: No. 6, 687-94(1971). (In French).

A method of producing a dispersion-strengthened Ni-Cr-ThO_2 alloy is described. Chromium powder is mechanically mixed with Ni-ThO_2 powder. A sintering-diffusion process, carried out in a halogen-hydrogen atmosphere in a temperature range of 900 to 1020°C, ensures the diffusion of chromium in nickel and yields a very porous Ni-Cr-ThO_2 alloy which has to be densified by extrusion. As in the case of Ni-ThO_2, thermomechanical treatment is needed to ensure good mechanical properties at high temperature. (auth)

9971 PREPARATION AND PROPERTIES OF W-Ni-Mo ALLOYS. Barta, J. (Israel Ministry of Defence, Tel-Aviv); Gorni, J.; Kimmel, G. High Temp. - High Pressures; 3: No. 6, 713-18(1971).

The preparation of W-Ni-Mo alloys containing 90 to 95% tungsten was investigated. The optimum sintering conditions were 1520°C, 1 h. The specimens, which were examined by optical microscopy and electron microprobe analysis, showed a two-phase structure composed of tungsten grains and W-Ni-Mo matrix. The examinations also indicated that quenching of the specimen caused the formation of solid solution (in the matrix) while slow cooling caused the formation of an intermetallic compound. The tensile strength of the specimens was low (20,000 to 30,000 lbf in^{-2}) with practically no elongation. The potential advantages of these alloys compared with the known heavy metals are higher hardness and better corrosion resistance than of alloys containing iron. (auth)

9972 IMPROVEMENTS IN OR RELATING TO SINTERING. Harrison, J. D. L.; Shephard, R. G.; Russell, L. E. (to United Kingdom Atomic Energy Authority). British Patent 1,292,651. 11 Oct 1972. Filed 17 Jan 1969.

A sintering technique is described that is applicable to a wide range of materials. In the case of a metal a fine powder is first compacted and then sintered. Sintering is carried out in a reducing atmosphere containing <50 ppM of O_2 and water vapor. The preferred particle size of the powder depends somewhat on the material, but should not exceed 10 μ and preferably should be less than 5 μ. The essence of the method resides in the discovery that very fine powders can be sintered to very high density provided they are prevented from oxidizing. These powders oxidize very readily and may even be pyrophoric, and the quoted limits of O_2 and water vapor in the atmosphere should therefore be regarded as maximum. Depending on the temperature and time of exposure less than these limits may be desirable. The sintering atmosphere is preferably H_2, although CO may be used, and the reducing gas may be mixed with a carburizing gas such as methane and/or an inert gas such as N_2 or Ar. A number of examples of application of the technique are described. (UK)

9973 IMPROVEMENTS IN OR RELATING TO ION BEAM MACHINING OF MATERIALS. Dugdale, R. A.; Ford, S. D.; Maskrey, J. T. (to United Kingdom Atomic Energy Authority). British Patent 1,290,863. 27 Sep 1972. Filed 5 Aug 1969.

Reference is made to apparatus for machining materials using a beam of ions from a glow discharge ion gun. Appertured masking means is provided for interrupting the ion beam, together with means for effecting relative movement between the object being machined and the masking means during operation of the apparatus, in order to obtain the desired contour. The masking means may be stationary with respect to the ion beam, or may be moveable so as to interrupt different portions of the beam. A grid structure is provided adjacent to the object to collect atoms sputtered from the cathode, the masking means, or the material being machined. A suitable glow discharge device is also described. (UK)

9974 DIFFUSION WELDING OF BERYLLIUM. PART I. BASIC STUDIES. Bosworth, T. J. (Boeing Co., Seattle). Weld. J. (N. Y.); 51: No. 12, 579s-90s(Dec 1972).

Studies were carried out to develop a diffusion welding process that would yield lap joints with usable properties at temperatures up to 800°F. This study was concerned with the development of basic welding parameters including the time-temperature-pressure-deformation relationships and the welding of sheet and plate of varying oxide contents. The study demonstrated that the weldability of beryllium is influenced by the BeO content and thickness, and that for each of these combinations of parts being welded there was a minimum amount of deformation required to cause welding. Welding conditions of 3 h at 1500 psi pressure at 1400 to 1500°F produced welds which had shear strengths exceeding 90% of the base metal shear strength at both room temperature and 800°F. (auth)

Properties, Structure, and Phase Studies

Refer also to abstracts 9480, 9482, 9488, 9489, 9511, 9799, 9801, 9921, 9934, 10057, 11225, 11228, 11229, and 11243.

9975 (COO-3476-2) STUDY OF THE MICRODYNAMICS OF INITIAL PLASTIC FLOW IN TUNGSTEN POLYCRYSTALS. Tandon, K. N. (State Univ. of New York, Stony Brook (USA). Dept. of Materials Science). Aug 1972. Contract AT(11-1)-3476. 82p. Dep. NTIS.

Thesis.

Investigation of the microdynamics of initial flow in high-purity tungsten polycrystals was carried out at room temperature with a view towards correlating the initial microflow behavior with the observed dislocation structure. Experiments were designed to ob-

tain all pertinent micro-mechanical data such as micro-stress–strain and the simultaneous time derivatives of stress and strain by employing multichannel recording techniques. Etch-pit microstructure was studied at progressively higher stress levels, and measurements were analyzed for values of the dislocation velocity which were typically $\approx 10^{-5}$ cm/sec for the initial dislocation sources activated. It was found that after activation dislocations did not move immediately to the grain boundary but rather moved a characteristic distance of $\approx 2 \times 10^{-3}$ cm which was only weakly dependent on applied stress for all strains $<10^{-4}$. The source production rate was also investigated for a large number of grains. Values of $\approx 4 \times 10^{4}$ (kg/mm^2) cm^2 were typical for the pre-yield region with this rate being independent of initial source density of a grain. For constant stress, a fixed number of dislocations (observed as a fraction of the total dislocation density) moved at constant velocity whereas in dynamical conditions the mobile dislocation density was not constant because of continual dislocation generation. This behavior caused a two-stage parabolic micro-yielding which could be interpreted according to these present observations as related to the slip mean free distance that dislocations moved. Upon activation all dislocations did not become part of the total mobile density for all higher stresses, but rather most became trapped by localized obstacles. At stresses approaching second micro-stage, these sources broke away and more new slip sources were generated; for them only the grain boundary acted as an obstacle. Some comparison studies on Fe–3% Si were also carried out. (auth)

9976 (COO-3476-3) SLIP INITIATION AND MICRODYNAMICS OF PLASTIC FLOW. Progress Report, January 1, 1972–December 31, 1972. Bilello, J. C. (State Univ. of New York, Stony Brook (USA). Dept. of Materials Science). 1972. Contract AT(11-1)-3476. 19p. Dep. NTIS.

Results of investigations are presented on flow dynamics in W monocrystals and polycrystals, plastic flow dynamics in Cu solid solutions, and generalized aspects of flow in coated single crystal systems. (J.R.D.)

9977 (NP-19614) NEUTRON DIFFRACTION STUDY OF ORDERED ARRANGEMENT OF Fe–Cr–Al ALLOYS. Kajzar, F.; Lesniewska, B.; Niziol, St.; Oles, A.; Pacyna, A.; Tucharz, Z. (Institute of Nuclear Techniques, Krakow (Poland)). Jun 1972. 8p. (INT-22). Dep. NTIS (U. S. Sales Only).

The ordering parameter in the Fe–Cr–Al alloys was determined by use of the neutron diffraction method. The Fe–Cr–Al alloys crystallize in a cubic system (bcc). The sites (0,0,0) are occupied by Fe and ($\frac{1}{2},\frac{1}{2},\frac{1}{2}$) by Cr, Al, and remaining Fe atoms. A strong influence of heat treatment on the ordering parameter was confirmed. (auth)

9978 REACTION OF AN Ni_3Al PHASE WITH Ni_3Ta. Mints, R. S.; D'yakonva, N. P.; Umanskii, Ya. S.; Bondarenko, Yu. A.; Bondarenko, T. A. (Moscow Inst. of Steel and Alloys). Dokl. Akad. Nauk SSSR; 206: No. 1, 87-8(1 Sep 1972). (In Russian).

X-ray phase analysis, microstructure, hardness, electrical resistance, thermal expansion, and thermal stability were investigated in the complete range of alloys of Ni_3Al–Ni_3Ta. The electrical resistance exhibited a sharp maximum at 50%. Both a maximum and minimum occurred in the heat stability curves (70 and 40% Ni_3Ta, respectively). The hardness curve had a gently rounded maximum at about 50%. The other variables are also discussed. (K.S.W.)

9979 INVESTIGATION OF THE STRUCTURE OF SINGLE AND POLYCRYSTALLINE MOLYBDENUM BY A COLORED ETCHING METHOD. Savitskii, E. M.; Burkhanov, G. S.; Lapshina, L. G.; Ottenberg, E. V.; Kataev, R. S. Izv. Akad. Nauk SSSR, Metal.; No. 3, 169(1972). (In Russian).

The crystallographic orientation, distribution of nonmetallic occlusions, and identification of the latter in Mo structures were investigated by a colored etching method. Colored plates reveal the presence of a dicarbide (0.01% C) in an O single crystal, and an oxide (0.05% O) at the grain boundaries of a polycrystal. (K.S.W.)

9980 PHASE FIELD BOUNDARIES IN THE W–Ta–Ti SYSTEM AT 1600°C. Tolmacheva, Z. I.; Kornilova, V. N. Izv. Akad. Nauk SSSR, Metal.; No. 3, 211-14(1972). (In Russian).

The isothermal cross section of the phase composition diagram of the ternary system W–Ta–Ti was constructed at 1,600°C using metallographic and x-ray techniques. The surfaces of the liquidus and solidus were projected onto a plane concentration triangular diagram. (K.S.W.)

9981 EFFECT OF THE COMPOSITION OF A MOLECULAR BEAM ON THE STRUCTURE OF VACUUM CONDENSATES OF NIOBIUM. Palatnik, L. S.; Obol'yaninova, O. A.; Naboka, M. N.; Gladkikh, N. T.; Khotkevich, V. I. Izv. Akad. Nauk SSSR, Metal.; No. 3, 81-4(1972). (In Russian).

The influence of the composition of a molecular beam on the phase states of condensed layers of Nb was investigated. The vaporization and condensation of Nb were conducted in a mass spectrometer. A current was passed through a 0.25 mm Nb wire to effect vaporization; the temperature of the wire could be controlled by current adjustment, and thus fix the relative amounts of Nb^+, NbO^+, and NbO_2^+ in the molecular beam. The transitory state of an fcc phase passing over into a bcc phase is discussed. (K.S.W.)

9982 REACTION OF HYDROGEN WITH METAL FILMS ON MOLYBDENUM AND COPPER SUBSTRATES. Rodin, A. M.; Grushina, V. V. Izv. Akad. Nauk SSSR, Metal.; No. 3, 85-8(1972). (In Russian).

Thin films (0.5 μ) of Ti, Sc, Y, Yb, Er, and Nd were deposited by vacuum sputtering on Mo and Cu substrates. Films on Mo were capable of absorbing H_2 at both high (800°C) and low (300°C) temperatures; those deposited on Cu would absorb H_2 only at low temperatures. Films of Y, Er, and Nd absorbed H_2 to achieve a H : metal ratio of 2.5 to 2.6; heating in a vacuum reduced these ratios to 1.6 to 2.0. (K.S.W.)

9983 INFLUENCE OF MOLYBDENUM AND TUNGSTEN ON THE PROPERTIES OF Ni–Cr–Nb ALLOYS. Sveshnikova, G. A.; Borzdyka, A. M. Izv. Akad. Nauk SSSR, Metal.; No. 3, 215-18(1972). (In Russian).

The combined introduction of W and Mo (up to 5% of each) in the alloy Ni–20%Cr–Nb served to raise its thermal stability at 750°C for periods of time up to 1,000 hr. The solubility of Nb in nickel–chromium solid solution was reduced between 700 and 900°C. Aging at relatively low temperatures caused the separation of a dispersed phase of Ni_3Nb which gradually transformed to a laminated structure. At high temperatures separation of the equilibrium laminated phase occurred directly. (K.S.W.)

9984 KINETICS OF SOLID PHASE REACTIONS IN THE SYSTEMS Ta–Be–Zr AND Nb–Be–Zr. Panov, A. S.; Rysina, M. M. Izv. Akad. Nauk SSSR, Metal.; No. 3, 219-23(1972). (In Russian).

The kinetics of solid phase reactions were investigated for the systems Ta–$ZrBe_{13}$ and Nb–$ZrBe_{13}$ at temperatures 900 to 1400°C. The growth of Ta and Nb beryllides was delimited by diffusion processes. The activation energy of the growth of a layer of $TaBe_2$ on Ta was 24.0 Kcal/mole; for $TaBe_5$, 49.0 kcal/mole; and for $NbBe_2$, 34.0 kcal/mole. (K.S.W.)

9985 PHASE DIAGRAM OF THE Nd–Sb SYSTEM. Kobzenko, G. F.; Chernogorenko, V. B.; Martynchuk, E. L.; Lynchak, K. A.; Skolozdra, R. V. Izv. Akad. Nauk SSSR, Metal.; No. 3, 224-7(1972). (In Russian).

The phase composition diagram for the system Nb–Sb was constructed, and four antimonides were found: Nd_5Sb_3, Nd_4Sb_3, NdSb, and $NdSb_2$, employing differential thermal, x-ray, and metallographic analyses. The least stable compound toward corrosion at 50°C was Nd_5Sb. A method of chemical analysis was developed for Nd–Sb alloys. (K.S.W.)

9986 TEXTURE OF INDIUM ALLOYS. Koryagina, M. V.; Khayutin, S. G. Izv. Akad. Nauk SSSR, Metal.; No. 3, 228-32 (1972). (In Russian).

The effects of temperature and the degree of deformation on the structure of In and In alloys were studied. In In that was rolled at 20°C the orientations (111)/11$\bar{2}$/, (113)/21$\bar{1}$, and a structure with a plane (001) predominated. In binary alloys of In with Tl, Pb, and Tl/Ag, the basic orientations were (001)/110/ and (113)/21$\bar{1}$. Increase in mechanical twinning was caused by alloying, low temperatures, and increased deformation and led to a change in texture of the foils. (K.S.W.)

9987 STRUCTURE IN THE MELT In–35 AT. PERCENT Tl. Romanova, A. V.; Il'inskii, A. G.; Bukhalenko, V. V. Izv. Akad. Nauk SSSR, Metal.; No. 3, 233-9(1972). (In Russian).

Alloying In with 35 at.% Tl resulted in a disturbance of the short-range order and of the natural crystal lattice. The structure of the liquid alloy In–Tl at 170 to 300°C contained a microregion with a short-range order of a different structural type. Various lattice arrangements (bcc, fcc, etc) are discussed in relation to the statistic distribution of In and Tl atoms, interatomic distances, x-ray scattering, and densities of the alloys. (K.S.W.)

9988 DIFFUSION OF CARBON IN TUNGSTEN–MOLYBDENUM STEELS. Zemskii, S. V.; Kupalova, I. K.; Baikov,

A. M.; Makarov, N. M. Izv. Akad. Nauk SSSR, Metal.; No. 3, 259-62(1972). (In Russian).

The diffusion coefficients of carbon were determined in four W–Mo steels with essentially the same C content and same total W + Mo content (6 to 10 wt %). With increasing Mo content in the α-solid solution, D_c, Q, and D_0 increased. Q remained nearly constant in the γ-phase. The increase in the activation energy of diffusion of C in these steels in the α-phase was associated with the large ionization energy of valence electrons of Mo^{6+} in contrast to W^{6+} in the solid solution in Fe, creating a large potential barrier for the migration of C. (K.S.W.)

9989 THERMODYNAMIC PROPERTIES OF LIQUID ALLOYS OF THORIUM WITH ZINC. Kanashin, Yu. P.; Lebedev, V. A.; Nichkov, I. F.; Raspopin, S. P. Izv. Akad. Nauk SSSR, Metal.; No. 3, 46-50(1972). (In Russian).

The thermodynamic characteristics of Th–Zn alloys and of the compound Th_2Zn_{17} were established using the emf method with a cell of the type: $Th_{solid}|electrolyte|Th-Zn_{liq.}$ in the temperature range 973 to 1,113°K. The solubility of Th in molten Zn was measured for the range 700 to 850°C. (K.S.W.)

9990 PHASE TRANSFORMATION IN SPLAT QUENCHED β-PHASE Au–Cd AND Au–Zn ALLOYS. Ferraglio, P. L. Brooklyn; Polytechnic Inst. of Brooklyn (1972). 174 p. University Microfilms Order No. 72-28,228.

Thesis.

The effect of splat quenching on the phases formed in near-equiatomic Au–Cd and Au–Zn alloys was studied, with particular emphasis on the resulting martensitic transformation products produced in the Au–Cd system. Alloys, of compositions Au–50 at.% Zn, Au–47.5 at.% Cd, and Au–50 at.% Cd, were liquid quenched, to room temperature, using a modified vertical shock-tube apparatus. The splat cooled foils were studied by the use of x-ray diffraction as well as by transmission electron microscopy and selected area electron diffraction. The long range order characteristic of these CsCl type β phase alloys could not be suppressed by splat quenching. It was found that immediately after liquid quenching the foils, in both the Au–Cd and Au–Zn alloys, contained only the CsCl β phase. On aging, at room temperature, the β phase in the Au–Cd alloys transformed to various martensitic products. For the Au–47.5 at.% Cd alloy the transformation was to, primarily, β_2 while in the 50 at.% Cd alloy β_1, β_1', γ_1, and ζ_1 were detected. Neither β_1 nor β_2' have been observed to transform to γ_1 on storage of the foils at room temperature. The dynamic nucleation and growth processes accompanying the formation of a martensitic phase were studied for the β_1 martensite in the Au–47.5 at.% Cd splat quenched foils. The transformation was initiated within the β phase by adjusting the electron beam intensity while the foil was under observation in the electron microscope, and the transformation exhibited thermoelastic behavior. Martensite nucleation was observed to occur either by the formation of isolated laths at β phase grain boundaries, by the creation of a lath front, by spontaneous lath formation at the interface between the β phase and an existing martensite lath, or by embryo initiation at dislocation-like features within the β phase grains. Lath nucleation was discussed in terms of a dislocation reaction on {110} β type planes involving screw dislocations. Growth of the β_1 martensite occurred either by propagation of individual laths, or by cooperative movement of many laths analogous to the single interface type transformation observed in bulk Au–47.5 at.% Cd single crystals. Growth of the martensite laths was smooth rather than erratic except when internal obstacles were encountered. The laths assumed wedge shaped or tapered ends, and growth of the lath proceeded by the movement of this tapered tip into the β phase. Isolated laths were found to have {110} β type interfaces. β_1 martensite was not observed to form in a step-wise manner, nor were any transition structures detected, rather the 3R martensite was present immediately behind the growing lath tip. Slight modifications to the internal structure of the laths was detected, and discussed in terms of transformation strains. Both a stabilization effect and a transformation hysteresis were encountered during the martensite tranformation, however, no detectable microstructural features were observed to be responsible for these phenomena. (Diss. Abstr. Int., B)

9991 SPACE SHUTTLE MATERIALS. VOLUME 3. National SAMPE Technical Conference, Huntsville, Alabama, October 5–7, 1971. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971). 742p. $35.00. (CONF-711054–(Vol.3).

Seventy-seven articles are included; a separate abstract was prepared for each of 35. The remaining 42 articles contain information on composite materials not in scope for NSA, e.g., high-temperature metals; reuse capabilities of materials; high-temperature insulation development; materials for life support and environmental control; materials compatibility with space shuttle environments; cryogenic insulation development; and special materials testing. (P.C.H.)

For abstracts of individual papers see: 9894–9897, 9956–9959, 9992–10007, and 10043–10053.

9992 HIGH TEMPERATURE SHEET ALLOYS: PROPERTIES, PROBLEMS, AND POTENTIAL. Lherbier, L. W.; Koffler, R. W. (Cyclops Corp., Pittsburgh). pp 169-82 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054–(Vol.3).

A review of popular iron-, nickel-, and cobalt-base high-temperature sheet alloys has been made relative to chemistry, properties, and availability. Emphasis has been put on the manufacturing and property problems associated with the production of thin gauge sheet. Additional problems associated with the fabrication of thin gauge sheet are also discussed in relation to welding and cold forming operations. The information emphasizes the importance of establishing a close technical relationship among supplier, fabricator, and user of parts made from high temperature alloy sheet. Also, ideas currently being considered for the development of improved sheet processing techniques are discussed. (auth)

9993 HIGH TEMPERATURE METALS FOR SPACE SHUTTLE. Loechel, Larry (Martin Marietta Corp., Denver). pp 183-200 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054–(Vol.3).

The results of a study to select the titanium alloys and superalloys that are most suitable for elevated temperature use on the space shuttle are presented. Methods of comparison of the properties of importance are described. Maximum use temperatures of the selected baseline alloys were established. (auth)

9994 DEVELOPMENT OF NEW NICKEL-BASE ALLOYS FOR HIGH -TEMPERATURE SERVICE. McCoy, H. E.; Gehlbach, R. E.; McNabb, B. (Oak Ridge National Lab., Tenn.). pp 245-58 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054–(Vol.3).

Several nickel-base alloys with the base composition of Ni–12% Mo–7% Cr–0.05% C and with additions of Ti, Nb, and Hf have been developed for use at moderate temperatures. It was found that the alloys are easier to fabricate than superalloys and are not embrittled by intermetallic compounds. (auth)

9995 EVALUATION OF THE PROPERTIES OF COLUMBIUM ALLOY WC3015. Tavassoli, A. A.; McKannan, E. C. (Marshall Space Flight Center, Huntsville, Ala.). pp 259-65 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054–(Vol.3).

Bare and coated specimens of Nb alloys WC3015 and Cb752 were cycled to 2400°F in vacuum. Tensile and bend tests on both alloys after 0, 5, and 20 exposure cycles were carried out. Substrate metal interaction of the alloys with VH112 and R512E coatings was considered with respect to mechanical properties. The most obvious difference between the alloys was the ductile-brittle transition temperature. (auth)

9996 APPLICATION OF THE LARSON–MILLER PARAMETER TO NIOBIUM-BASE ALLOYS. Stephenson, R. L. (Oak Ridge National Lab., Tenn.). pp 269-76 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054–(Vol.3).

Several mathematical relationships have been proposed for the extrapolation of creep-rupture data. Larson and Miller (Trans. ASME 74, 765(1952)) have proposed such a formulation. Their equation has been applied to creep data for seven niobium-base alloys (FS-85, Cb-752, SU-16, SU-31, C-129Y, D-43, and B-66). Master curves are given for 1% creep, 2% creep, 5% creep, rupture, and minimum creep rate. The limitations of such methods for extrapolation are discussed. (auth)

9997 TENSILE BEHAVIOR OF HIGH-STRENGTH ALLOYS DURING RAPID HEATING. Hauser, Daniel (Battelle Memorial

Inst., Columbus, Ohio); Wright, James W. Jr. pp 277-85 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Studies of tensile behavior were conducted on two grades of maraging steel, Ti-6Al-4V titanium alloy, and 7075-T6 aluminum alloy by applying a high tensile stress at room temperature that was maintained during subsequent rapid heating to failure. The results were compared to properties obtained from standard room- and elevated-temperature tensile tests. Significant differences in tensile behavior between these types of evaluations were found that demonstrate the need for developing design properties under conditions that closely simulate launch and reentry service conditions. (auth)

9998 NONDESTRUCTIVE EVALUATION OF THE THICKNESS VARIABILITY IN SILICIDE-COATED COLUMBIUM ALLOYS. Maykuth, Daniel J.; Bartlett, Edwin S. (Battelle Memorial Inst., Columbus, Ohio). pp 287-97 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Thickness measurements were conducted on approximately 1000 coupons of the Cb752 and C129Y niobium alloys which had been slurry silicide coated with the R512E and VH109 formulations. The measurement techniques used metallographic evaluation to correlate with various methods including micrometer, eddy current, and thermoelectric probe. In general, the best correlation for all of the coating systems represented was achieved with pointed-anvil micrometer measurements. The coating thickness values obtained were subjected to statistical analysis and variances were determined for different sample groupings of both coatings. The implications of the thickness variabilities indicated for these present state-of-the-art coated alloys on the design of coated hardware for the Space Shuttle are discussed. (auth)

9999 MECHANICAL FASTENERS FOR THE SPACE SHUTTLE. Roach, Thomas A. (Standard Pressed Steel Co., Jenkintown, Pa.). pp 301-4 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Various aspects of mechanical fasteners are discussed as they relate to the high temperature structures of the Space Shuttle. Suggestions for design are presented along with a discussion of some of the problem areas which exist. Some data are presented for Haynes 188 and TD NiCr fasteners. (auth)

10000 WELDING AND BRAZING OF ADVANCED REFRACTORY ALLOYS. Slaughter, G. M.; Canonico, D. A.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). pp 309-14 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The weldability of commercial refractory alloy sheet materials was compared for manual and automatic tungsten-arc and electron-beam processes. Brazing alloys are also described for joining graphite, refractory metals, and refractory oxides for high-temperature service without pretreatment. (auth)

10001 EFFECT OF MULTIPLE ENTRY ON THE PROPERTIES OF SUPERALLOYS. Davis, John W. (McDonnell Douglas Astronautics Co., St. Louis). pp 327-37 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The Space Shuttle Program imposes a new and unique environmental constraint on selection of thin gage thermal protection materials, that of multiple reentries. The effects of multiple reentry exposures on the mechanical properties of several thin gage superalloys were examined in this program. The alloys studied are currently prime candidates for portions of the thermal protection system on the Space Shuttle. Changes in properties of René 41, Haynes 188, and TD-NiCr were examined after cyclic exposure to a simulated Shuttle flight profile. The simulation included simultaneous and varying temperature, pressure, and stress levels throughout the exposure. In addition to conducting standard tensile tests after reentry simulation, creep measurements were made after every 25 simulated reentry cycles. The results of these measurements indicate that excessive creep deformations can occur during reentry simulation. The creep deformations are far in excess of those predicted by the best available data and, as such, must be properly characterized to ensure the most effective use of superalloy properties in the design of the space shuttle thermal protection system. The results of tensile tests indicated that after 100 reentry cycles, strength reductions of the order of 40 to 60% of the room temperature tensile strength can occur. (auth)

10002 EVALUATION OF METALLIC MATERIALS FOR SPACE SHUTTLE BOOSTER THERMAL PROTECTION SYSTEM. Johnson, H. A.; Bosworth, T. J.; Torgerson, R. T. (Boeing Co., Seattle). pp 339-49 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

A test program was conducted to evaluate candidate materials and provide preliminary data for the Space Shuttle booster thermal protection system design studies. Materials included in the program were the Ti-6Al-2Sn-4Zr-2Mo, Inconel 718, René 41, Haynes 188, and TD-NiCr. The objective of the program was to determine the degradation of the materials when exposed to 100 cycles of a simulated booster environment. (auth)

10003 COATED COLUMBIUM FLAW GROWTH IN THE SPACE SHUTTLE ENVIRONMENT. Bartlett, Edwin S.; Maykuth, Daniel J. (Battelle Memorial Inst., Columbus, Ohio). pp 359-66 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Flaws were intentionally introduced in commercial R512E and VH109 coatings on niobium alloys proposed for use as TPS materials in the Space Shuttle. These were then exposed to "static" (controlled vacuum leak) and "dynamic" (hypersonic plasma shear) oxidation. The results showed that under some conditions dynamic exposure is necessary to realistically predict the response of flawed, coated niobium. (auth)

10004 PROTECTIVE COATINGS FOR COLUMBIUM APPLIED IN THE FIELD. Carter, James (Marshall Space Flight Center, Huntsville, Ala.); Culp, John. pp 367-70 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Niobium alloy panels with protective coatings are an important part of the Space Shuttle thermal protection system. The use of coated niobium in a practical multimission operational system requires that damage to the coating be repairable by simple and reliable techniques. All aspects of field repair of coated panels are described. The first problem is to define what coating conditions require repair and what is the significance of not repairing a known defect in the coating. Test information is presented to qualitatively define the effects of several damage causes. The structural integrity of panels with unrepaired coating damage are determined by flight simulation testing. The field repair of the coatings is accomplished by employing ceramic cement repairs, and reapplying the fused slurry silicide coating. The ceramic cement repairs have the advantage that they are easy to apply, and the lives and reliability have been substantially improved. The reapplication of the fused slurry silicide has in the past been the most reliable method of repair; however, it has been difficult to apply in a true field repair. Techniques have been developed to improve the practicality of these repairs by employing torch heating. The repair coating quality is demonstrated by testing which simulates flight temperature, pressure, stress, and acoustic vibration conditions as a function of time with three by twelve in. panel specimens of a representative design. Conclusions on the present status of field repair coatings are presented, and appropriate future activities relative to the use on an operational Space Shuttle system are recommended. (auth)

10005 ENHANCED FLAW GROWTH IN SSE MAIN ENGINE ALLOYS IN HIGH PRESSURE GASEOUS HYDROGEN. Frick, V.; Janser, G. R.; Brown, J. A. (Aerojet Liquid Rocket Co., Sacramento, Calif.). pp 567-604 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The effects of high pressure gaseous hydrogen upon candidate alloys for the Space Shuttle Main Engine components were evaluated for static load conditions using surface flawed flat plate PTC specimens. Alloys evaluated included Inconel 718, Udimet 700,

Hastelloy X, A-286, Armco 21-6-9, and Ti5Al-2.5Sn ELI. Tests were performed in high purity, gaseous hydrogen at a pressure of 7500 psig and temperatures in the range of −320°F to +1000°F. Electron beam weld joints were also evaluated for some alloys. (auth)

10006 AQUEOUS STRESS CORROSION CRACKING AND STRESS CORROSION FATIGUE OF A HIGH STRENGTH TITANIUM ALLOY. Williams, J. C.; Paton, N. E.; Stocker, P. J.; Marcus, H. L. (North American Rockwell Science Center, Thousand Oaks, Calif.). pp 613-21 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The influence of external variables such as electrochemical potential and stress intensity factor on stress corrosion crack propagation rate in Ti−6Al−2Sn−4Zr−6Mo has been studied under static loading and dynamic loading conditions. The influence of microstructure on the operative fracture mode and the response of the alloy to stress corrosion cracking has been investigated. Conclusions were drawn as to the relative effects of environment and microstructure on crack propagation rate. (auth)

10007 OXIDATION SCREENING AT 1204° C (2200° F) OF CANDIDATE ALLOYS FOR THE SPACE SHUTTLE THERMAL PROTECTION SYSTEM. Sanders, W. A.; Barrett, C. A. (Lewis Research Center, Cleveland). pp 679-88 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The oxidation resistance of fifteen alloys was evaluated under some of the environmental conditions that might be encountered by the shuttle thermal protection system. The alloys included nickel-, iron-, and cobalt-base wrought alloys. Specimens were self-resistively heated to 1204°C in a 10 torr still air environment for 100 thirty-minute cycles. Specimen weight, thickness, and microstructural changes were noted and surface scales were identified by room temperature x-ray diffraction. Based on these observations, the behavior of the alloys was evaluated in terms of overall amount of metal consumption due to oxide formation and relative tendency toward oxide spalling and scale vaporization. (auth)

10008 TECHNIQUES ASSOCIATED WITH THE USE OF SPECIAL METALS. III. TANTALUM AND NIOBIUM. Perez, M.; Syre, R. (Societe Trefimetaux, Paris). Mater. Tech.; No. 12, 299-301(Dec 1971). (In French).

There are important similarities between the physical properties of Ta and Nb. These characteristics lead to applications in the aeronautic and space industries and in the nuclear industry. Ta possesses remarkable anticorrosion properties (applications to chemical engineering). The principal mechanical properties of Nb and Ta are presented. Nb has less interesting properties than Ta; its semi-products, however, are marketed at a price comparable with that of Ta and have the advantage of a smaller density. Established processes for producing and transforming these metals are presented. (France)

10009 TEMPERATURE DEPENDENCE OF SOLIDIFICATION BEHAVIOR IN CADMIUM POLYCRYSTALS DURING STRETCHING TESTS. Maennel, Peter; Hoetzsch, Guenter; Guenther, Fritz. Neue Huette; 17: No. 9, 521-5(Sep 1972). (In German).

The solidification behavior of cadmium polycrystals was studied in the temperature range from 20 to 250°K and with different grain sizes. In connection with literature references, results are evaluated and interpreted with respect to texture. Cadmium deforms itself not only through base gliding but also through twin formation, especially at low temperatures, gross grains, and crystal orientations around $\chi = 0°$. If in the tensile deformation of polycrystals the start of creep is carried predominantly by twin formation, the solidification curve shows initially one or two linear roses. The tensile limit below 150°K is either temperature-independent or falls with lower temperature. Dominance of glide processes at the beginning of creep, conversely, causes a parabolic solidification curve and a low-temperature rise of $\sigma 0.2$. (tr-auth)

10010 VZRYVOOPASNOST' METALLICHESKIKH POROSHKOV. (Explosion Danger of Metal Powders). Nedin, V. V.; Neikov, O. D.; Alekseev, A. G.; Krivtsov, V. A. Kiev; Naukova Dumka (1971). 140p.

The burning of metallic powders in gaseous media, and the physical properties of such powders, in relation to their explosive characteristics are considered in some detail in this monograph. The pyrophoric aspects of powdered Al, Mg, Zr, U, Ti, Th, B, Cr, Ta, and V are compared. Explosion chambers, and apparatus for determining temperatures of spontaneous combustion, for determining the concentrations of suspended particles in air, and for determining the specific surface of powders are described. The theory and mechanism of combusion of powders, the energy released, and methods of propagation of a detonation are discussed. 244 references. (K.S.W.)

10011 PROPERTIES OF AUSTENITIC STAINLESS STEELS FOR NUCLEAR REACTORS. Matejovic, Karel; Staif, Milan (Skoda Concern, Plzen, Czech.). Jad. Energ.; 18: No. 11, 371-6 (Nov 1972). (In Czech).

The properties of a newly developed austenitic chromium-nickel stainless steel are described which is alloyed with small quantities of molybdenum, niobium, and additions of zirconium and cerium. The steel was manufactured in the size of 13-ton ingots and worked to a plate of the thickness of 60 mm. The mechanical properties dependence on the temperature and on the heat treatment of the base material and welded joints are described along with the structural changes and precipitation characteristics of carbide phases and how they affect the intercrystalline corrosion resistance in the heat-affected zone of welded joints. (auth)

10012 HYDROGEN CONTAMINATION IN TANTALUM AND NIOBIUM FOLLOWING UHV-DEGASSING. Faber, K.; Schultz, H. (Max-Planck Institut fuer Metallforschung, Stuttgart). Scr. Met.; 6: No. 11, 1065-70(Nov 1972).

Discussions are presented on observations of spurious electric resistivity effects in Nb and Ta related to the presence of H at about 50 at. ppM in ultra-high vacuum (UHV) degassed samples. Discussions are also included on the mechanism of H pick-up after UHV-degassing and on methods of preventing such H contamination. (J.R.D.)

10013 REPLY TO ON THE FRACTURE ENERGY OF MOLYBDENUM. Ayres, R. A. (Michigan Technological Univ., Houghton); Stein, D. F. Scr. Met.; 6: No. 11, 1043-6(Nov 1972).

Results of a range of experimental techniques are resolved and presented which support the position that the {110} plane in Mo is the plane of lowest surface energy. The proposed model of Caglioti et al. [Scr. Met., 11: 1041-2(1972)] fails in its prediction of the experimental results. The proposed cleavage model of Ayers and Stein [Acta. Met., 19: 789(1971)] is in accord with experimental evidence for the bcc metals where dislocation motion does occur around the tip of the crack. Therefore, while the Caglioti model appears to be well formulated, it apparently over-estimates the importance of the second and third nearest neighbor bonds in determining the surface energy of molybdenum and tungsten. Since the Ayres and Stein model can explain why the {100} plane would be the cleavage plane even though the {110} plane is the plane of lowest surface energy, it is not troubled by the inconsistency required in applying the Caglioti approach. (J.R.D.)

10014 FRACTURE ENERGY OF MOLYBDENUM. Bilello, J. C. (State Univ. of New York, Stony Brook); Caglioti, G. Scr. Met.; 6: No. 11, 1041-2(Nov 1972).

A method of calculating surface energy of Mo is presented in which the effects of dispersion and of strong second, third, etc., nearest neighbor interactions are taken into account. It is shown that when these effects are considered the ratio $\gamma_{100}/\gamma_{100} \sim 1$, with γ_{100} slightly smaller than γ_{110} for Mo. (J.R.D.)

10015 OVERHEATING OF THE HEXAGONAL MODIFICATION OF ZIRCONIUM ABOVE THE POLYMORPHIC TRANSITION TEMPERATURE UNDER PULSE HEATING CONDITIONS. Martynyuk, M. M.; Tsapkov, V. I. (Friendship of Nations Univ., Moscow). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1558-9(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1806-7(Jun 1972).

A α-Zr wire was heated in air by a 400-μsec current pulse. Current and voltage oscillograms were used to calculate the dependence of the relative resistance R/R_0 of Zr on its molal enthalpy H. The kinks in the curve represented the beginning (H_α) and end (H_β) of the polymorphic transition and the beginning (H_S) and end (H_L) of the fusion process. $H_\alpha = 30.5$, $H_\beta = 35.0$, $H_S = 60.0$, and $H_L = 81.5$ kJ/mole. H_S, H_L and $H_L - H_S$ were in good agreement with published values, indicating no shift in mp. The heat of the polymorphic transition $H_\beta - H_\alpha = 4.5$ kJ/mole also was in good agreement, but H_α was 5.3 ± 1.8 kJ/mole larger than published data, indicating overheating of the α phase. This overheating was estimated to be 150°K for 35 μsec. (D.L.C.)

10016 FATIGUE CRACK PROPAGATION IN STAINLESS STEEL WELDMENTS AT HIGH TEMPERATURE. Shahinian,

P.; Smith, H. H.; Hawthorne, J. R. (Naval Research Lab., Washington, D. C.). Weld. J. (N. Y.); 51: No. 11, 527s-32s(Nov 1972).

The resistance to fatigue crack propagation of weld and of base metal in Types 304 and 316 stainless steel submerged arc weldments have been evaluated at 77, 800, and 1100°F (25, 427, and 593°C). Rates of crack growth were determined as a function of the stress intensity factor range. In general, the crack growth resistance of weld metal was about the same as or greater than that of the base metal. The superiority of weld over base metal was greatest at 1100°F (593°C) as the loss of fatigue resistance with increase in temperature was less for the weld metal. Type 316 weld metal had better resistance to fatigue crack growth than Type 308 weld metal, and Type 304 base metal had better resistance than Type 316 base metal. (auth)

10017 COMPATIBILITY OF TANTALUM WITH GRAPHITE, UO_2, AND UC. Muraoka, Susumu; Itami, Hiroharu; Nomura, Sueo. Nippon Genshiryoku Gakkaishi; 14: No. 11, 580-8(Nov 1972). (In Japanese).

The compatibility of Ta with graphite, UO_2, and UC at high temperature was studied in consideration of its impact on the safety aspects of capsule irradiation in the JMTR. It was revealed that Ta reacts with graphite above 1,200°C. Ta was compatible with UO_2 in the temperature range of 1,400–2,000°C. Ta, however, proved to react with UC above 1,400°C, and above 1,600°C there occurred penetration of U into Ta. The reaction of Ta–C and Ta–UC, both manifested parabolic growth behavior of the reaction layers, which is indicative of diffusion controlled reaction. The diffusion coefficients obtained from these experiments are: $D^C_{Ta_2C} = 1.7 \times 10^{-3} \exp(-26.0/RT)$ cm²/sec (1,400–1,800°C), $D^C_{TaC} = 4.5 \exp(-103/RT)$ cm²/sec (1,800–2,350°C), and $D^C_{Ta_2C} = 6.2 \times 10^2 \exp(-146/RT)$ cm²/sec (1,800–2,350°C). (auth)

10018 STRUCTURE AND EROSION RESISTANCE OF Mo–Cu CERMET HEAVY-CURRENT CONTACTS. Zhavoronkov, M. A.; Levchenko, G. V.; Minakova, R. V.; Teodorovich, O. K. (Moscow Electrotechnical Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 4, 72-8(Apr 1972). (In Russian).

During an investigation of the structure of working surfaces and character of electric erosion of contacts, it was found that the alloying element (cobalt) content, necessary to improve technological properties (erosion resistance) of contact materials should be a minimum and not exceed 1% by weight. (auth)

10019 RECENT MATERIALS COMPATIBILITY STUDIES IN REFRACTORY METAL–ALKALI METAL SYSTEMS FOR SPACE POWER APPLICATIONS. Harrison, R. W. (General Electric Co., Cincinnati); Hoffman, E. E.; Davies, R. L. pp 11,12-17 of Energy 70, Proceedings, Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

Advanced Rankine and other proposed space power systems utilize refractory metals in contact with both single-phase and two-phase alkali metals at elevated temperatures. A number of recent compatibility experiments are described which emphasize the excellent compatibility of refractory metals with the alkali metals, lithium, sodium, and potassium, under a variety of environmental conditions. The alkali metal compatibilities of tantalum-, niobium-, molybdenum-, and tungsten-base alloys are discussed. (auth)

10020 ANOMALOUS SLIP IN HIGH-PURITY NIOBIUM SINGLE CRYSTALS DEFORMED AT 77°K IN TENSION. Bolton, C. J.; Taylor, G. (Oxford Univ.). Phil. Mag.; 26: No. 6, 1359-76(Dec 1972).

High-purity niobium crystals with a center-triangle axial orientation were deformed in steps at 77°K. Each crystal was cut to a square cross-section and a reference grid applied to two adjacent surfaces before deformation. At each deformation step the lengths and orientations of the grid sides were determined, and using this information the amounts of slip on eight independent systems of (110)(111) type were calculated. The results showed that most of the deformation occurred on the lightly stressed systems $(0\bar{1}1)(\bar{1}11)$ and $(0\bar{1}1)(111)$ with very little slip on the primary $(\bar{1}01)(111)$ and conjugate $(101)(\bar{1}11)$ systems. This analysis confirms earlier observations on high purity niobium deformed at low temperatures, which showed that $(0\bar{1}1)$ slip lines predominated (anomalous slip). The data show that the conjugate Burgers vector is almost twice as active as the primary. In the earlier stages of deformation the straining proceeded by a series of small load drops, but later the curve became smooth. The slip lines were very similar to those observed on round crystals. Anomalous $(0\bar{1}1)$ slip at large strains has only been observed in crystals of niobium purified by ultra-high vacuum annealing; other bcc metals and alloys, and niobium purified by zone-refining do not exhibit this type of deformation. The origin of anomalous slip remains a mystery; it is possible that a solution will come out of the recent atomistic calculations on screw dislocations in a bcc structure. (UK)

10021 UTILIZING THE RESISTANCE TO MICROPLASTIC DEFORMATION DURING AGING OF BERYLLIUM. Lokshin, I. Kh.; Khenkin, M. L.; Levina, N. K. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 3-4, 242-3(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 3, 54-5(Mar 1972).

Commercial and distilled beryllium has the highest resistance to microplastic deformation after aging at 500 and 400°C, respectively. The aging of beryllium depends on the presence of iron in it. (auth)

10022 RECRYSTALLIZATION OF NICKEL HARDENED WITH THORIUM DIOXIDE. Babich, B. N.; Lyukevich, V. I.; Levinskaya, M. Kh.; Romashov, V. M. Metal Sci. Heat Treat. (USSR) (Engl. Transl.); 14: No. 3-4, 222-5(1972).

Translated from Metalloved. Term. Obrab. Metal.; 14: No. 3, 36-40(Mar 1972).

Dispersion-hardening nickel has exceedingly high structural stability, which explains the retention of the hardness of the cold-drawn material after annealing at high temperatures. The material is characterized by a large temperature range between recovery, occurring at 400 to 600°C, and recrystallization, which develops at 1200 to 1400°C. During recrystallization of dispersion-hardened nickel, structural heterogeneities occur that are stable up to 1400°C ($0.97T_m$). The number of large recrystallized grains depends on the degree of prior deformation and the annealing temperature. Recrystallization processes are activated in nickel hardened with thorium dioxide as the degree of cold deformation increases. However, a relatively large degree of deformation (83%) prevents the formation of large recrystallized grains. (auth)

10023 NUCLEAR QUADRUPOLE INTERACTIONS IN LIQUID ALLOYS. Claridge, E.; Moore, D. S.; Seymour, E. F. W.; Sholl, C. A. (Warwick Univ., Coventry, Eng.). J. Phys., F (London); 2: No. 6, 1162-73(Nov 1972).

Nuclear spin-lattice relaxation rates have been measured as a function of composition for ^{115}In and ^{121}Sb in liquid In–Sb and for ^{115}In and ^{209}Bi in In–Bi, and as a function of temperature for ^{209}Bi in $Bi_{50}X_{50}$ where X = In, Sn, Sb, Pb, and for ^{27}Al in $Al_{89}Si_{11}$. For ^{121}Sb in In–Sb and for ^{209}Bi in all the alloys investigated a relaxation rate was observed in excess of that predicted by the Korringa relation. The additional rates R_{1Q} are attributed to an electric quadrupolar interaction with diffusing ions. The composition and temperature dependence of R_{1Q} can be understood in terms of an extension of the theory of Sholl (Proc. Phys. Soc.; 91: 130-43(1967)) which was developed for pure liquid metals provided that the three body term largely cancels the two body term in the theory. Direct calculations have not as yet confirmed such a complete degree of cancellation. The relative field gradients which must be attributed to different ions in an alloy do not bear any simple relation to their valences. (auth)

10024 STRUCTURE AND PROPERTIES OF DISPERSION-STRENGTHENED COBALT ALLOYS. Drapier, J. M.; Coutsouradis, D.; Habraken, L. (Centre National de Recherches Metallurgiques, Liege). High Temp. - High Pressures; 3: No. 6, 659-75(1971).

The microstructures and properties of various experimental dispersion-hardened alloys in the as-received and heat-treated conditions are described. The alloys included Co-2ThO_2-0.2Zr, Co-4ThO_2, Co-10Ni-2ThO_2-0.2Zr, and Co-20Ni-18Cr-2 and 4ThO_2. The techniques used in the microstructural study were primarily light microscopy, transmission electron microscopy on thin foils, x-ray diffraction, and electron microprobe analysis. The effect of variables affecting composition, structure, processing, etc., on the strengthening mechanisms in dispersion-strengthened materials is discussed on the basis of the experimental results and also in terms of data in the literature pertaining to the mechanical strength of the alloys. (auth)

10025 ROLE OF FIBER BOUNDARIES DURING DRAWING OF POWDER METALLURGICAL TUNGSTEN WIRES. Millner, Tivadar; Varga, Laszlo; Veroe, Balazs (Research Inst. for Technical Physics, Budapest). Z. Metallk.; 63: No. 11, 754-6 (Nov 1972).

On tensile testing of powder metallurgical un-annealed tungsten wires at room temperature the sliding of the fibers plays a decisive role. A uniform elongation and reduction in area of the wires arises not by a uniform volume contraction but mainly by a relative displacement of the individual fibres. Necking will take place if the sliding of the fibers remains limited to one section. The contraction during tensile testing is no volume deformation

in the usual sense, but it is due to sliding of the metal fibers which may be deduced from their reduction in number in the cross-section. If no transverse stresses act on the boundaries the wire will exhibit ductile properties. If transverse stresses do occur, however, the fibers will suffer brittle fracture. Usually the fibers will separate in a completely brittle manner. (auth)

10026 HARDNESS-CONTROLLING ADDITIONS IN TRANSITION METAL–BERYLLIUM ALLOYS. Baer, H. G.; Pfeiffer, Irmtraud (Vacuumschmelze GmbH, Hanau, Ger.). Z. Metallk.; 63: No. 11, 740-4(Nov 1972). (In German).

In nickel-beryllium and cobalt-iron-beryllium alloys containing up to 2 wt. % Be, additions of chromium, molybdenum and tungsten as well as niobium, tantalum and titanium lead to high hardness values which are maintained over very long aging times, if the age-hardening takes place in the recrystallized state. The effect of the additions in this type of age-hardening is based upon an almost complete suppression of precipitation of the equilibrium phase on grain boundaries and the consequent stabilization of the intermediate phase in the grain interiors. In age-hardening in the cold-worked state, the alloy additions slow the transition from the intermediate to the equilibrium phase, which proceeds as a continuous process. Moreover, the decomposition rate per se is diminished, for one finds, in contrast to addition free alloys, microstructural region which recovers faster than they decompose and, consequently, age-harden like recrystallized specimens. The sizes of the atomic radii of the alloy additions and their influence on the strain energy at the coherent phase/matrix interface, and the binding relationships between the additional elements and those of the base alloy are used to explain the results. Moreover, the influence of the additions on the vacancy concentration and, in conjunction, on the discontinuous precipitation of the equilibrium phase on grain boundaries is discussed. (auth)

10027 STATISTICAL CONSTITUTION ANALYSIS: LOGICAL DECISION PATTERN. Mager, Tilman; Petzow, Guenter (Univ., Stuttgart). Z. Metallk.; 63: No. 11, 702-9(Nov 1972). (In German).

In order to distinguish five constitutional classes a statistical analyzing method is developed. By comparison of 420 binary phase diagrams it relates 17 atomic and thermodynamic parameters (parameters of the components) to the classes. This relation is found by dimensionless correlation factors which come from different defining equations. Each correlation diagram is set up by two correlation factors and all the systems which are related to each constitutional class form point distributions in each correlation diagram. The valuation of the point distributions by frequency criterions leads to frequency factors, frequency areas and frequency curves. These frequencies are quantitatively expressed by analytic expressions. With the aid of these mathematic relations 24 single-tests are set up. Using the point density as an index for the overlapping of single-tests, the separating behavior of the tests with respect to the classes is investigated. To improve the efficiency of the tests, all single-tests are combined to form a Logical Decision Pattern. In this pattern each single-test provides a contribution to the final decision. The pattern itself is represented by a computer program and furnishes probability statements on the type of constitutional class of a system in question. (auth)

10028 PHASE DIAGRAMS AND PROPERTIES OF BINARY ALLOYS OF REFRACTORY METALS REGARDING THE ELECTRON STRUCTURE OF THE COMPONENT ATOMS. Samsonov, G. V.; Nasarenko, V. V. (Inst. for Problems in Materials Studies, Kiev). Z. Metallk.; 63: No. 11, 717-19(Nov 1972). (In German).

Transition metal atoms may act as electron acceptors as well as donors upon their interaction. The conditions for optimum electron exchange of Group IV to VI transition metals in binary alloys are given. From these the coordinates of the minima and of the eutectics on the liquidus-solidus curves can be derived. It is assumed that optimum electron exchange results in maximum electron localization in alloys. The extreme values of some alloy properties which are sensitive to electron localization support this assumption. (auth)

10029 [10$\bar{1}$1] TWINNING IN ZIRCONIUM SINGLE CRYSTALS DEFORMED AT ELEVATED TEMPERATURES. Tenckhoff, Erich (Siemens AG, Erlangen, Ger.). Z. Metallk.; 63: No. 11, 729-34 (Nov 1972). (In German).

The operating twinning systems in zirconium single crystals compressed in a $\langle 11\bar{2}3\rangle$ direction depend on the temperature of deformation. For this orientation at 20°C twinning of the type $\{10\bar{1}2\}$ occurs. At 250 and 500°C twins of the type $\{11\bar{2}2\}$ are observed. At 650 and 750°C a new twinning system becomes operative, namely $\{10\bar{1}1\}$. The twinning elements related to this system are: K_1, the composition plane: $\{10\bar{1}1\}$, η_1, the shear direction: $\langle\bar{1}012\rangle$, K_2, the second undistorted plane: $\{\bar{1}013\}$, η_2, the line of intersection between K_1 and the plane of shear: $\langle 30\bar{3}2\rangle$, and The plane of shear: $\{1210\}$ and s, the shear for zirconium with c/a = 1.5931: 0.1044. (auth)

10030 FRACTURE OF FIELD-ION MICROSCOPE SPECIMENS. Wilkes, T. J.; Titchmarsh, J. M.; Smith, G. D. W.; (and others) (Oxford Univ.). J. Phys., D (London); 5: No. 12, 2226-30(Dec 1972).

The premature failure of field-ion microscope specimens, either during preparation or in the microscope, was investigated using scanning and transmission electron microscopy. Specimen materials were tungsten, tungsten–rhenium–hafnium–carbon alloy, molybdenum, molybdenum TZM alloy, iridium, nimonic alloy, and titanium carbide. Four distinct kinds of endform were found. Many specimens showed evidence for classical brittle failure while others appeared to have failed in a ductile manner. In some cases it appeared that local heating or even melting occurred. When only a small amount of material is removed in the fracture event, an almost perfect field-evaporation endform can result. Some materials were found to fail in more than one way according to the prior treatment of the specimen. The behavior is correlated with the mechanical stresses induced by the electric field in the field-ion microscope and during specimen preparation. The causes and avoidance of failure are discussed. (auth)

Radiation Effects

Refer also to abstracts 11188, 11190, and 11206–11208.

10031 (CONF-721115–1) CORRELATION OF STRUCTURE AND DUCTILITY OF IRRADIATED AUSTENITIC STAINLESS STEELS. Bloom, E. E. (Oak Ridge National Lab., Tenn.). 1972. 15p. Dep. NTIS.

From European conference on irradiation embrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Reduced ductility and an increased tendency for grain boundary fracture were observed when austenitic stainless steels were irradiated with neutrons. The magnitude of the ductility loss and the fracture mechanism depended on the irradiation temperature through its influence on the type, size, and concentration of irradiation-produced defects. For irradiation conditions that produced an increased matrix strength, crack propagation occurred, leading to low-ductility intergranular fractures. With increasing temperature crack propagation decreased, and the tendency for grain boundary failure by cavitation increased. (auth)

10032 (CONF-721115–2) POSTIRRADIATION TENSILE PROPERTIES OF ANNEALED AND COLD-WORKED TYPE 316 STAINLESS STEEL. Fahr, D.; Bloom, E. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). 1972. 24p. Dep. NTIS.

From European conference on irradiation enbrittlement and creep in fuel cladding and core components; London, England (9 Nov 1972).

Tensile properties of annealed and cold-worked Type 316 stainless steel irradiated at temperatures between 450 and 850°C to a maximum fluence of 2.7×10^{22} neutrons/cm^2 (E > 0.1 MeV) have been compared to those of unirradiated Type 316 stainless steel in the as-annealed, annealed-and-aged (4000 h), as cold-worked, and cold-worked-and-aged (4000 h) condition. The results showed that fast-neutron irradiation substantially reduces the ductility of the annealed material. The postirradiation work-hardening rate and ductility in the annealed as well as-cold-worked material was highest at an irradiation and test temperature of about 500°C. At this temperature dynamic strain aging took place in both the annealed and cold-worked specimens irradiated at about 500°C while no such contribution to the work-hardening rate could be observed for unirradiated, cold-worked specimens at any temperature. The postirradiation ductility of cold-worked specimens was, therefore, significantly higher than that of unirradiated specimens in the cold-worked and cold-worked-and-aged condition at temperatures between 450 and 550°C. (auth)

10033 (EURFNR–1025) CREEP CAPSULES FOR FUEL AND CLADDING MATERIAL. Haefner, H.; Neumann, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Mar 1972. 42p. (KFK–1571). Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Creep data of the fuel and cladding material are necessary prerequisites to the design of advanced fuel elements for nuclear reactors. One in-pile capsule each for cladding and structural materials, respectively, was developed at the Institute of Materials and Solid Research of the Karlsruhe Nuclear Research Center which allow the in-pile measurement of elongations of the respec-

tive samples under axial pneumatic stress. An inductive measurement system was selected for both types of capsules. A minimum of two samples can be irradiated at a time in each rig. This results in advantages, both in terms of time and expense, of these in-pile experiments relative to existing facilities. The different systems of measurement and a creep capsule for irradiation of cladding and structural materials in the Belgian BR2 reactor at Mol are described. A fuel creep capsule for the FR2 research reactor at Karlsruhe is described. In addition, the operating experience and results are outlined. (auth)

10034 (SRARI-P-154) ENERGY AND ENTROPY OF MIGRATION OF DEFECTS ORIGINATED IN PLUTONIUM UNDER NEUTRON IRRADIATION. Raetskii, V. M. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1972. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results are given on isochronous and isothermal annealing of electrical resistance and length of α-plutonium irradiated by 1.8×10^{15}, 5×10^{15}, and 0.57×10^{15} fissions/cm^3 at 77°K. The results are analyzed assuming proportionality of changes in the defect concentration to electrical resistance, length, and annealing time according to the reaction of the first and second order. (auth)

10035 (UCRL-51223) PHOTOGRAPHIC STUDIES ON EFFECTS OF HIGH-LEVEL, SHORT-TERM RADIATION ON VARIOUS METALS. Reedy, Robert; Dittmore, Claude (California Univ., Livermore. Lawrence Livermore Lab.). 16 May 1972. Contract W-7405-eng-48. 18p. Dep. NTIS.

The factors involved in obtaining high-speed color photographs of melting material samples located in a pulse reactor are discussed. Those factors are illumination, optics, camera speed, object distance, physical characteristics of samples, radiation shielding for film, film type, and film processing. (auth)

10036 THEORY OF CREEP IN A FAST REACTOR. Gittus, J. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Scr. Met.; 6: No. 11, 1079-82(Nov 1972).

The causes of creep of non-fissile material in fast reactors are examined. It is proposed that radioinduced creep occurs because the climb process is inflexible and therefore leads to internal stresses that can only be relieved by plastic yielding. Equations are included to express the rate of plastic straining and creep during swelling. (J.R.D.)

10037 NOBLE METAL ION BOMBARDMENT OF POLYCRYSTALLINE METAL SURFACES. Burrow, N. G.; Burtt, R. B. (King's Coll., London). J. Phys., D (London); 5: No. 12, 2231-51(Dec 1972).

Measurements have been made of electron ejection and positive ion reflection from clean and contaminated vacuum-deposited films of silver, gold and aluminium by positive ions of nitrogen, sodium, copper, silver and gold with incident kinetic energies between 20 and 500 eV. An attempt has been made to account for the experimental results by calculating the effects of ion neutralization. (auth)

10038 INTERNAL FRICTION IN POLYCRYSTALLINE COPPER FOILS AFTER ALPHA-IRRADIATION AT 78°K. Kaniak, Ernst; Muellner, Helga (Univ., Vienna). Z. Metallk.; 63: No. 11, 724-9(Nov 1972). (In German).

Polycrystalline copper foils (of 7 to 15 μm thickness) were irradiated at 78°K with α-particles from a ^{210}Po source. The foils, fixed at one end, could be excited in a transverse mode of vibration. The changes in Young's modulus and in internal friction were determined by measuring the frequency and the decrement of the sample vibrations in free decay (0.3 to 1.5 kHz). The change in Young's modulus with increasing dosage at the irradiation temperature includes both the modulus increase, which has been recognized as a dislocation effect, and the decrease, which has been designated as a volume effect. The internal friction first decreased by dislocation pinning and then increased with increasing radiation dose. After irradiation, the temperature dependence of the internal friction showed distinct peaks between 80 and 140°K. The activation enthalpy for reorientation of two of these peaks and also that for annealing of one of them could be determined. From the annealing behavior, the peaks were ascribed to the reorientation of interstitial-impurity-complexes. (auth)

Other Materials

Refer also to abstracts 9487, 9522, 9600, 9991, 11191, 11224, 11241, 11264, 11311, and 11362.

10039 (AREAEE-146) SINTERING OF CALCIUM FLUORIDE. Haroun, N. A.; Orabi, G. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Metallurgy). 1972. 13p. Dep. NTIS (U. S. Sales Only).

The sintering of CaF_2 in the temperature range of 500 to 1000°C was investigated. An optimum sintering temperature of 700 to 900°C was found. Variation of the compacting pressure from 5000 to 40000 psi did not affect the sintered density. The effect of 0.3 and 1% of the additives MgO, NiO, ZnO, Cr_2O_3, and MnO_2 on the densification of CaF_2 was investigated. MgO and MnO_2 could result in some improvement. Variation of the particle size of 0.3% MgO additions had no effect on densification. A detailed discussion of the results suggested bulk diffusion as the main mechanism for the densification of CaF_2. (auth)

10040 (GERHTR-33) DETERMINATION OF THE DISTRIBUTION OF AMORPHOUS PARTICLES IN PYROCARBON COATINGS BY MEANS OF "COLD OXIDATION." Luhleich, H.; Suetterlin, L.; Hoven, H.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). 17 Dec 1970. 12p. Dep. NTIS.

Work performed under United States-German High Temperature Reactor Research Exchange Program.

A method known as "cold oxidation" was developed by which structures of apparently isotropic pyrocarbon coatings of nuclear fuel particles can be rendered visible. It is based on the dry oxidation of the pyrocarbon at room temperature by highly excited oxygen. The amorphous parts of the pyrocarbon coatings burn off more quickly than the pyrocarbon itself, a relief-like coating structure appearing. It is shown that there is a correlation between the structure of the pyrocarbon coatings after "cold oxidation" and their behavior under fast neutron irradiation. (auth)

10041 (LA-5062) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 20: Summary of Progress from November 1, 1971-January 31, 1972. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 10p. Dep. NTIS.

Research and development are reported on phenolic resin binders, coke flour, binder soaking, hot molding glass-like carbons, and particle packing. (J.R.D.)

10042 (RHEL/R-251) EPOXY RESINS FOR SUPERCONDUCTING MAGNET ENCAPSULATION. Evans, D.; Morgan, J. T.; Stapleton, G. B. (Rutherford High Energy Lab., Chilton (England)). Sep 1972. 27p. Dep. NTIS (U. S. Sales Only). UK 35 pence.

Experimental work on the evaluation of epoxy resin systems for use at liquid helium temperatures is reported. The various criteria are discussed and the tests used to evaluate the potential worth of a large number of systems are described. Tabulations are given of the performance of selected resin systems. (auth)

10043 OVERVIEW OF COMPOSITES FOR SPACE SHUTTLE STRUCTURES. Cataldo, C. E. (Marshall Space Flight Center, Huntsville, Ala.). pp 1-7 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The Space Shuttle, proposed as an earth-to-orbit reusable vehicle, presents a challenge to materials and design engineers to apply light-weight materials. To provide large payloads, the shuttle structure must be as light weight as possible, yet possess a high degree of structural integrity over a lifetime of multiple flights. The general maturity of advanced composites considered for various components of the shuttle is reviewed, and the range of potential applications for such materials is discussed. (auth)

10044 HIGH TEMPERATURE STRENGTH DEGRADATION OF ADVANCED COMPOSITES. Hertz, Julius (General Dynamics, San Diego, Calif.). pp 9-16 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

It was discovered that aging at room temperature in an office or laboratory environment can significantly lower the high temperature strength properties of graphite- and boron-reinforced epoxy composites. Several potential mechanisms for this degradation are discussed and supported by environmental test data. Means of recovering high temperature strength properties are also described. (auth)

10045 CONTINUOUS CASTING OF METALLIC TUBULAR STRUCTURAL ELEMENTS REINFORCED WITH BORON FILAMENTS. Abrams, Edwin F.; Davies, Lawrence G.; Powers, William M.; Shaver, Robert G. (General Technologies Corp.,

Reston, Va.). pp 39-47 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The continuous casting technique of metal matrix compositing has been used to produce unidirectionally-reinforced tubes of continuous boron filament in light metal alloy matrix. The continuous casting operation is described. The strength and density properties of the tubes produced by this process were found to be highly dependent on the matrix alloy used. For the purpose of load-bearing structures for the space shuttle these tubes provide an unparalleled combination of strength, stiffness, stability and economy. (auth)

10046 EVALUATION OF ADVANCED METAL MATRIX COMPOSITE MATERIALS. Christian, J. L. (General Dynamics Corp., San Diego, Calif.). pp 49-59 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Mechanical property testing was conducted on a number of promising new advanced metal matrix composite materials. These included boron/stainless steel/aluminum, boron/aluminum made from large-diameter boron filaments, and continuously cast boron/aluminum and boron/magnesium composite materials. Test results indicated that boron/stainless steel/aluminum possesses excellent mechanical properties and should now be considered for aerospace structural applications. Also, advanced metal matrix composite materials made from large-diameter filaments and those made by continuous casting methods exhibited excellent mechanical properties and show considerable promise for low-cost, high-quality composites of the future. (auth)

10047 METAL MATRIX FABRICATION PROCESSES. Miller, M. F.; Schaefer, W. H. (General Dynamics Corp., San Diego, Calif.). pp 61-8 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Metal matrix subcomponents typical of those found in the airframe industry have been fabricated by both tape consolidation and sheet brazing methods. Materials examined in this study include both plasma-sprayed and diffusion-bonded tapes and consolidated sheet material of Borsic-Ti-Al and B-stainless steel-Al. Secondary fabrication studies have been performed for forming and machining metal matrix composites. (auth)

10048 DEVELOPMENT OF BORON-EPOXY TUBULAR STRUTS FOR A ONE-THIRD SCALE SHUTTLE BOOSTER THRUST STRUCTURE. Engler, Erich (Marshall Space Flight Center, Huntsville, Ala.); Hadcock, Richard. pp 83-98 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

A one-third scale booster thrust truss structure was designed by Grumman under an in-house program using both boron/epoxy and titanium for the tubular strut members. The boron/epoxy design showed a 22 percent weight saving and a two phase demonstration program was subsequently funded by NASA-MSFC. In the first phase, structural elements and the most highly loaded center member of the truss were fabricated and tested. The second phase consists of fabrication and test of a complete two-dimensional truss. The design, analysis, fabrication, and test procedures are discussed along with the results of successful tests on the elements and center member conducted under the first phase of the NASA program. (auth)

10049 BORON-EPOXY REINFORCED STRUCTURAL SECTIONS. Roy, Paul A.; McElman, John A.; Henshaw, Jim (Avco Systems Div., Lowell, Mass.). pp 111-27 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

A NASA Research program on the development of lightweight aluminum stiffening sections will be reviewed. The sections under investigation are hollowed extrusions which have been reinforced with boron epoxy by means of a fiber infiltration scheme being developed by Avco. Advantages of this type of construction are cost, environmental stability, manufacturing flexibility, and simplicity in joining. Present studies are focused on developing and verifying structural concepts for stiffener sections for compression panels. Results of analytical studies to size boron reinforcement will be discussed. Compression test results on stiffener sections will be presented and the design of a large compression panel will be reviewed. Results from compression panel efficiency studies indicate that panels with infiltrated stiffeners may be as much as 25% lighter than comparable all aluminum panels. (auth)

10050 BUCKLING OF BORON/ALUMINUM AND GRAPHITE/RESIN FIBER COMPOSITE ANISOTROPIC PANELS. Chamis, C. C. (Lewis Research Center, Cleveland). pp 137-47 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Theoretical results are presented for the buckling of anisotropic plates. The plates are subjected to simple and combined inplane loading. The plates are made from fiber composite material of boron/aluminum or high modulus graphite/resin. The results are presented in nondimensional form as buckling load versus fiber orientation angle for various plate aspect ratios. (auth)

10051 COMPOSITE SPACE SHUTTLE ENGINE SUPPORT STRUCTURE. Lager, John R. (Martin Marietta Corp., Denver). pp 149-56 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Design and analysis of Space Shuttle booster and orbiter main engine support structures that use various amounts of conventional metals and advanced fibrous composites indicates that the incorporation of fibrous composite materials can result in a significant weight savings. The selective reinforcement concept for booster engine support beams and the orbiter engine support truss retains conventional metal in regions of complex stress state while reinforcing with fibrous composite where the load path is well defined. Load is transferred to the fibrous composite through gradual shear-in over a step-tapered region. Advancement to the all-composite design approach requires that a maximum amount of fibrous composite material be utilized. In this design approach, an end attachment and load transfer capability is provided by thin metal shim inserts. The properties of conventional Al and Ti along with B-epoxy, graphite-epoxy, and B-Al fibrous composites for the designs are listed and discussed. (auth)

10052 COMPOSITE SEALS FOR LIQUID HYDROGEN AND NUCLEAR RADIATION ENVIRONMENTS. Van Auken, R. L.; Chase, V. A. (Whittaker Corp., San Diego). pp 557-66 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

Plastic composite seals for service in a liquid hydrogen and nuclear radiation environment were developed. The radiation resistant aromatic heterocyclic class of polymers, including polyimide (PI), polybenzimidazole (PBI), and polyquinoxaline (PQ), were evaluated for this application. The seal developed is based on a design involving a resin starved laminate consisting of alternating layers of woven glass fabric and polymer film. This design imparts a mechanical spring characteristic to the seal, resulting in essentially complete elastic recovery when unloaded, and eliminates cold flow. Encapsulating techniques employing the PQ polymer were developed which rendered the seal impervious to liquid hydrogen. The seals were tested before and after nuclear irradiation up to 10^{10} ergs/gram (C) gamma. Load/deflection and leakage tests were performed over a temperature range of -423°F through +500°F. (auth)

10053 MULTILAYER INSULATION MATERIALS FOR REUSABLE SPACE VEHICLES. Leonhard, K. E. (General Dynamics, San Diego, Calif.); Hyde, E. H. pp 645-77 of Space Shuttle Materials. Vol. 3. Azusa, Calif.; Society of Aerospace Material and Process Engineers (1971).

From National SAMPE conference; Huntsville, AL. (5 Oct 1971). See CONF-711054-(Vol.3).

The evaluation of multilayer insulation materials suitable for repeated space vehicle operation is discussed. Materials studied were radiation shields, shield spacers, blanket face sheets, fasteners, and adhesives. The Superfloc MLI concept-Kapton shields goldized on both sides as the radiation barrier with Dacron flock tufts as the spacers-appeared to be an excellent MLI for reusable cryogenic tankage. Superfloc configurations

consisting of various combinations of film, spacer, and adhesive materials were manufactured and tested. The effects of compression and subsequent recovery were determined by subjecting goldized Kapton Superfloc to loads varying from 5×10^{-4} to 1×10^{-2} psi. Tensile, flexing, expansion, and cycling tests were performed on goldized Kapton and Mylar Superfloc and Beta glass reinforced Pyre ML face sheet material. The thermal conductivity of PPO 531 (polyphenylene oxide) was determined between −416 and 318°F. A face sheet material that retains its shape was developed by coating Beta glass scrim material with Pyre ML polyimide wire enamel. PPO material was selected for fabricating lightweight twin and tri-pin fasteners, together with grommets, face sheets, and reinforcement tabs. The thermal conductivity of two high-temperature Superfloc specimens consisting of 15 layers of goldized Kapton sheets and Dacron spacers was measured in the ADL Model 12 double-guarded calorimeters. (auth)

10054 ANISOTROPY VARIATION OF CRYSTALLOGRAPHIC ORIENTATION IN PYROCARBON COATINGS OF FUEL PARTICLES BY ANNEALING AND NEUTRON IRRADIATION. Koizlik, K. Juelich, Ger.; Kernforschungsanlage Juelich GmbH (1972). 95p. (In German).

Thesis.

Optical measurements to determine the orientation anisotropy directly of pyrocarbon coatings of fuel particles are described. A correlation was detected between anisotropy factors by means of optical and x-ray measurements. The optical measurement was used to detect the orientation anisotropy and its variation by annealing and neutron irradiation of the particle coatings. Also, dependencies are shown between the material properties of pyrocarbon, annealing or irradiation data, and the anisotropy increase. To explain the measured results, a model is discussed and compared with those suggested in the literature. (GF)

10055 TRANSMISSION ELECTRON MICROSCOPY OF PYROLYTIC CARBONS DEPOSITED IN A BED OF FLUIDIZED PARTICLES. Kaae, J. L.; Gulden, T. D.; Liang, S. (Gulf General Atomic, Inc., San Diego, CA). Carbon; 10: No. 6, 701-9(Dec 1972).

The microstructures of a number of pyrolytic carbons deposited in a bed of fluidized particles under widely varying conditions have been studied by transmission electron microscopy. Growth features were apparent in all of these carbons and, depending on the deposition conditions, included large or small grains, small growth cones, or spheres. Small structural features such as cracks within the growth features and pores at the boundaries of growth features were also observed and varied with the deposition conditions. Implications of the microstructures with regard to the deposition mechanisms of these carbons are discussed. (auth)

10056 EFFECT OF ANNEALING ON THE MICROSTRUCTURES AND THE MECHANICAL PROPERTIES OF POORLY CRYSTALLINE ISOTROPIC PYROLYTIC CARBONS. Kaae, J. L. (Gulf General Atomic, Inc., San Diego, CA). Carbon; 10: No. 6, 691-9(Dec 1972).

The structural and mechanical property changes which occur when poorly crystalline isotropic pyrolytic carbons are heated to temperatures in the range 1400 to 1900°C have been studied. Transmission electron microscopy was used to observe the structural changes, and three-point bending was used to measure the mechanical property changes. The x-ray crystallite sizes of the carbons increased during annealing as did the length of diffraction-contrast fringes observable in the electron microscope. At the highest annealing temperature, cracks developed in the high-density carbons where large crystallite size increases occurred but not in the low-density carbons where crystallite size increases were small. Young's modulus and fracture stress decreases due to annealing were most pronounced in the high-density carbons and were least pronounced in the low-density carbons. However, in all of the carbons the strain energy to fracture remained constant during annealing. (auth)

10057 HELIUM POSITIONAL BEHAVIOR IN METAL MATRICES UNDER TEMPERATURE GRADIENTS. Rodriguez Perazza, M. F. Tucson, AZ; Univ. of Arizona (1972). 49p. University Microfilms Order No. 72-30,384.

Thesis.

Helium migration behavior in an aluminum matrix was determined at temperatures from 472 to 818°K with temperature gradients from 74°K/cm to 208°K/cm. Helium was observed to migrate from lower to higher temperatures by bubble transport controlled by surface diffusion. The aluminum matrix was charged with helium from the (n,α) reactions with boron-10. A boron film on the aluminum surface was irradiated in the TRIGA reactor at The University of Arizona to introduce the helium into the material. Both the temperatures and the temperature gradients were monitored by temperature sensitive paint and by thermocouples. The migration distances and bubble sizes were measured by electron microscopy techniques using the Hitachi HU-200 microscope in the Department of Metallurgical Engineering at The University of Arizona. Migration velocities ranged from 220Å/sec for bubbles of 200 Å radius under a temperature gradient of 91°K/cm at 508°K to 3500Å/sec for bubbles of 2200Å in radius under a temperature gradient of 208°K/cm at 758°K. The experimental diffusion coefficients were found to be independent of crystal orientation or temperature gradient. The surface diffusion coefficient for aluminum under the conditions of this experiment is $D_s = 4.78 \times 10^3 \exp [-(0.890/kT)]$ where k is expressed in electron volts/°K and T in degrees Kelvin and the heat of transport was assumed to be 0.67 the heat of vaporization of aluminum. (Diss. Abstr. Int., B)

10058 CATALYTIC EFFECT OF SILICON ON STRUCTURES OF SILICONATED PYROLYTIC GRAPHITE. Yajima, S. (Tohoku Univ., Sendai); Hirai, T.; Hayase, T. Carbon; 10: No. 6, 752-4 (Dec 1972).

Properties are shown for co-deposited pyrolytic graphite silicon compound prepared by pyrolyzing a mixture of hydrocarbon gas and halogen vapor including Si as an additive. The conditions for preparation are given and the relation between Si content and density, Si content and interlayer spacing, also Si content and crystallite size are illustrated. Results are compared with material prepared by other workers. (UK)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

10059 (K-1839(Pt.1)) BEHAVIOR OF THE URANIUM ISOTOPES IN SEPARATION CASCADES. PART I. IDEAL CASCADES. Blumkin, S.; Von Halle, E. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 21 Nov 1972. Contract W-7405-eng-26. 62p. Dep. NTIS.

Basic background information on the characteristic behavior of ^{234}U, ^{235}U and ^{236}U in ideal separation cascades has been developed as a first step in a study aimed at an assessment of the usefulness of measurements of the concentrations of the minor uranium isotopes in cascade feed and withdrawal streams as a complementary safeguards technique for ^{235}U enrichment plants. It has been determined that the ^{234}U content, and also the ^{236}U when present, relative to that of the ^{235}U of all ideal cascade streams are affected by design specifications such as the ^{235}U product concentration, the ^{235}U tails concentration, the isotopic composition of the feed uranium, the relative quantities of the feeds when more than one kind is used and the magnitude of a partially enriched side withdrawal, if any. The isotopic data are independent of the value chosen for the separation factor for ^{235}U from ^{238}U and of the scale of the separation job. The variation of the size and shape of ideal cascades with the design variables is also reported. (auth)

10060 (LA-5071) ^{252}Cf ASSAY SYSTEM FOR FBR FUEL PINS: DESCRIPTION AND OPERATING PROCEDURES MANUAL. Menlove, H. O.; Forster, R. A.; Parker, J. L.; Smith, D. B. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 28p. Dep. NTIS.

This manual describes the ^{252}Cf assay system for the measurement of FBR fuel pins. The following topics are included: a general description of the system, details concerning the neutron moderator and shield, a description of the gamma-ray detectors and electronics, the automated system control and associated software, and data evaluation and error analyses. The system described is in operation at the Westinghouse-HEDL Pu fuel facility in Richland, Washington. (auth)

Disposal and Storage

Refer also to abstracts 9434, 9439, 9485, 9486, 9553, 9559, 9560, 9568, and 9569.

10061 (ARH-SA-124) ENGINEERED STORAGE OF RADIOACTIVE WASTE. Szulinski, M. J.; Warren, J. H. (Atlantic Richfield Hanford Co., Richland, Wash.); Elgert, O. J. (Atomic Energy Commission, Washington, D. C.). Nov 1972. Contract AT(45-1)-2130. 17p. (CONF-721107-2). Dep. NTIS.

From Symposium on the management of radioactive wastes from fuel reprocessing; Paris, France (27 Nov 1972).

Radioactive waste materials must be stored or disposed of in such a manner that isolation from the biosphere is assured until they have decayed to innocuous levels. An alternative to an ultimate disposal which depends upon the surveillance and administration of man, is an engineered storage. An Engineered Storage Facility is being studied. Storage concepts involving air, water and conduction cooling were considered and storage in cooled water basins was selected for further development. A modular construction schedule is proposed to minimize investment and to utilize technological advancements. (auth)

10062 (RISO-276) INCORPORATION IN BITUMEN OF LOW-LEVEL RADIOACTIVE WASTE WATER EVAPORATOR CONCENTRATE AT THE DANISH ATOMIC ENERGY COMMISSION RESEARCH ESTABLISHMENT RISOE. Larsen, Ib (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1972. 18p. Dep. NTIS (U. S. Sales Only).

The plant for evaporation of radioactive waste water at the Research Establishment Risø has been in operation since 1959. The concentrate from this plant is stored as a semi-liquid, soluble sludge. Since November 1970 the concentrate has been incorporated in bitumen to form an insoluble solid. A description is given of the necessary laboratory experiments. The design principles for and experiences of operation with the finished bituminization plant are given. (auth)

10063 DISPOSAL OF RADIOACTIVE WASTES. Krause, H. (Kernforschungszentrum, Karlsruhe, Ger.). Naturwissenschaften; 59: No. 9, 412-17(Sep 1972). (In German).

Depending on geological and geographical conditions, there are three main methods for the ultimate disposal of low- to intermediate-level radioactive wastes from the operation of nuclear installations: burial in the ground, storage in salt formations, and disposal in the ocean. Under appropriate underground conditions, radioactive effluents can be injected into porous strata and radioactive concentrates can be pressed into shales. For the disposal of highly active, heat-generating wastes salt formations are best suited. (31 references). (auth)

10064 RESEARCH AND EXPLOITATION OF CIVIL ENGINEERING TECHNIQUES CONCERNED WITH ATOMIC POWER PLANTS. 2. TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES. Inoue, Y. (Kyoto Univ., Japan). Doboku Gakkaishi; 57: No. 2, 41-6(Feb 1972). (In Japanese).

The difference between the terms treatment and disposal is clarified. Special attention is given to radioactive waste disposal into the ocean and the ground. Some underlying concepts and fundamental problems concerning radioactive waste disposal are discussed. For example, the concept of "permissible dose," "doubling dose," and "partial permissible dose" are explained in detail and the problem of biological concentration of radioactive materials is discussed using "concentration factors" for various elements. The importance of estimating diffusion of wastes is also stressed. Various methods and problems in the disposal into the ocean and ground are also discussed. (Japan)

10065 SELECTION OF A SITE FOR THE GROUND DISPOSAL OF RADIOACTIVE WASTES. I. AN APPROACH TO SAFETY ANALYSIS. Inoue, Yoriteru; Morisawa, Shinsuke (Kyoto Univ.). Nippon Genshiryoku Gakkaishi; 14: No. 10, 522-30(Oct 1972). (In Japanese).

Disposal of radioactive solids or solidified wastes in the ground is at present forbidden in Japan, mainly because of the difficulties in the evaluation of the migration of leaked radionuclides and of the radiation dose to which the public would be exposed by the disposed wastes. First of all, the behavior and the migration of radionuclides in the environment is quantitatively expressed. Then, the internal dose rate received by the public is estimated under suitable assumptions. Ten radionuclides contained in radioactive wastes and three ecological paths of the nuclides in the environment are discussed (i.e., the paths through drinking water, seafoods, and vegetables). It is concluded that the critical nuclides in this disposal scheme are ^{90}Sr and ^{110m}Ag, and that the internal dose is mainly governed by the intake through vegetables. The safety of the ground disposal of radioactive wastes is also evaluated. (auth)

Handling Equipment and Procedures

Refer also to abstract 11501.

10066 (GAT-DM-1175) SHIPMENT OF 8-INCH I.D. CYLINDERS OF UF_6 AT ENRICHMENTS TO 97.65 PERCENT ^{235}U AND 12-INCH I.D. CYLINDERS OF UF_6 AT ENRICHMENTS TO 30.00 PERCENT ^{235}U AT LIMITED MODERATION: AND SUBSEQUENT CYLINDER CLEANING. Feuerbacher, J. L. (Goodyear Atomic Corp., Piketon, Ohio). 23 Feb 1972. Contract AT(33-2)-1. 23p. Dep. NTIS.

Report GAT-T-1745 presented significant preliminary results concerning effects on K_{eff} of array size and spacing, interstitial water, and concrete array reflection. It also dealt tentatively with subsequent cylinder decontamination, based on hand calculations. Important additional computer results concerning these matters are presented. For wet decontamination, use of cadmium plating instead of non-reflection was investigated, and to a limited extent its effect on allowable shipment numbers. Other minor items are also included. (auth)

10067 (Y-1858) VALIDATION CHECKS OF THE "ANISN" AND "KENO" CODES BY CORRELATION WITH EXPERIMENTAL DATA. Handley, G. R.; Hopper, C. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 20 Nov 1972. Contract W-7405-eng-26. 32p. Dep. NTIS.

The one-dimensional, discrete-ordinates transport computer code ANISN and the Monte Carlo computer code KENO are employed to calculate critical experiments of various geometries, materials, and uranium-235 enrichments. The input parameters to the codes are included in an Appendix. It is concluded that reliable criticality safety calculations can be made for a wide range of systems of general interest, provided the limits of validated applicability are not exceeded. (auth)

Transportation

10068 (EUR–4884) CRITICAL ANALYSIS OF APPLICATION OF THE EURATOM BASIC SAFETY STANDARDS TO THE TRANSPORT OF NATURAL AND ARTIFICIAL RADIOACTIVE SUBSTANCES WITHIN THE MEMBER STATES. Failla, L.; Faloci, C.; Susanna, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Oct 1972. 196p. Dep. NTIS (U. S. Sales Only). EUR B. Fr. 250.-.

This study was carried out in order to provide the most detailed account possible of the practical application of Euratom's basic safety standards to transport activity of natural and artificial radioactive substances in the six Community States. It is classified under four sections dealing respectively with the following subjects: (I) scope of the basic standards; (II) application of the basic standards in the Community States; (III) comparison between the basic standards and the international standards; and (IV) conclusion and proposals. A particular discussion is centered around some aspects of the basic standards which are considered of particular interest for the field of transport of radioactive materials. These are: information, authorization and inspection; controlled area and protected area; and classification of workers employed on the transport and of the population affected by it. The four sections are supplemented by three appendices which give useful information to people interested in this field. Appendix A compares the various international standards, Appendix B the standards in force in the six states, and Appendix C deals with the specific Italian experience in this sector. (auth)

10069 (GAT-DM–1125) GUIDE TO NUCLEARLY SAFE USE OF 8" I.D. CYLINDERS FOR UF_6 AT ASSAYS ABOVE 12½ PERCENT ^{235}U, AND 12" I.D. CYLINDERS AT ASSAYS ABOVE 5 PERCENT ^{235}U. Feuerbacher, J. L. (Goodyear Atomic Corp., Piketon, Ohio). 30 Oct 1968. Contract AT(33-2)-1. 31p. Dep. NTIS.

An earlier study has shown that 8 in. ID × 48 in. nickel cylinders of UF_6 are safe at assays up to 97.65% ^{235}U, and 12 in. ID × 48 in. nickel cylinders are safe at assays up to 30% ^{235}U, provided the moderation is kept at or below an H/U atomic ratio of 0.2 in both cases, and normal fill limits are not exceeded. The precautions given should suffice to maintain nuclear safety in actual applications of this new criterion. Problems concerning such safe application of these liberalized limits have been carefully considered. Safe cylinder decontamination has also been considered. Additional KENO code computer calculations have been employed where appropriate. Aspects of reduced fill limits in 12 in., 10 in., and 8.7 in. ID cylinders at higher assays, and of shipping number limits for 8 in. and 12 in. cylinders, were also investigated. (auth)

10070 (MLM–1981) SAFETY ANALYSIS REPORT FOR PACKAGING (SARP) MODEL AL-M1 NUCLEAR PACKAGING. Griffin, J. F.; Edling, D. A.; Winemiller, C. D. (Mound Lab., Miamisburg, Ohio). 30 Nov 1972. Contract AT-33-1-Gen-53. 80p. Dep. NTIS.

A formal safety analysis report for the AL–M1 radioactive materials shipping containers is presented that makes available to all potential users the technical information and limits pertinent to the construction and use of the AL–M1 configuration-1 and -3 shipping containers. Complete physical and technical descriptions of the packages are presented. Both configurations utilize a 55-gal, steel drum, outer container lined internally with 3½ in. of insulation to protect the O-ring sealed inner containers from impact and fire. The results of the nuclear criticality safety analysis show that 1.9 to 4.3 kg of ^{239}Pu or 5.6 to 16.8 kg of ^{235}U may be shipped as Fissile Class II. Fissile classes are established for combinations of ^{239}Pu and ^{235}U when shipped together. Design and development considerations required to prove the containers' ability to withstand a sequence of four hypothetical accident conditions are discussed. The four tests described are the free drop, puncture, thermal and water immersion tests defined by the AEC and the DOT to simulate transportation accident conditions. The inner containers were successfully helium leak tested following the hypothetical accident test sequence. Maximum safe pressures during accident fire conditions, a maximum anticipated thermal decay energy of 10W, and a maximum content weight of 20 kg are established. The tests did not damage the AL–M1 inner containers in any way that would cause release of the specified radioactive materials. ^{239}Pu and ^{235}U will not cause the packaging to be breached even under accident test conditions. The validity is proven by basing the container design on an earlier design, which was fully tested by General Electric's Hanford Atomic Products Operation in 1964, and thereby confirms the initial Monsanto Research Corp. safety evaluation for obtaining the Department of Transportation permit DOT-SP-5549. A sequence of photographs illustrates and documents the accident test results; and tables, graphs, sketches and technical references are included. Copies of permit DOT-SP-5549, OSD/ALO approvals, and the original GE safety report are contained in the Appendix. (auth)

10071 (RFP–1867) TECHNICAL DOCUMENTATION FOR MODEL 2030-1 SHIPPING CONTAINER (DOT SPECIAL PERMIT 5332). Adcock, F. E.; McCarthy, J. D.; Wackler, W. F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 16 Nov 1972. Contract AT(29-1)-1106. 28p. Dep. NTIS.

The Model 2030-1 container is used by Rocky Flats Division, Dow Chemical U.S.A., for shipping unirradiated fissile material in solid form. Components consist of a 30-gallon steel drum, Celotex insulation, and a stainless steel containment vessel of 10-inch diameter. Approved material limits include 5-kilograms of plutonium or 11-kilograms of enriched uranium. Thermal decay energy is normally limited to 20-watts. Higher values are permissible by modifying the design and observing certain restrictions. AEC Approval (AL-R4) and DOT Special Permit 5332 were issued in 1967, based on the engineering evaluation by Rocky Flats. Results of recently conducted tests show the containment vessel temperature rise will not exceed 140°F during the thermal test. A unique and simple venting system to prevent container rupture is described and time/pressure data determined during a 30-minute furnace test at 1475°F are given. All technical data for the package are provided, as required by an Immediate Action Directive (IAD 0529-24) change to AEC Manual Chapter 0529. (auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

10072 (BNL-17454) ANTICIPATED AVERAGE DOSE IN ISABELLE. Bennett, G. W.; Levine, G. S. (Brookhaven National Lab., Upton, N. Y.). 7 Dec 1972. 4p. Dep. NTIS.

An order of magnitude calculation is used to obtain the average radiation exposure of ISABELLE components. (auth)

10073 (CERN-Trans-72-11) INDUCED RADIOACTIVITY AT THE IHEP PROTON SYNCHROTRON. Golovachik, V. T.; Britvich, G. I.; Lebedev, V. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN), from report IFVE-ORZ-69-76. 15p. Dep. NTIS (U. S. Sales Only).

An analysis of the composition and space distribution of induced radioactivity radiation, both in terms of its components and energies, along the accelerator and at target stations at the Serpukhov Synchrotron is given. Data are presented which can be used as a basis for radiation protection studies and to predict the future build-up rate of induced activity. (W.H.K.)

10074 (INR-1415) DETERMINATION OF DOSE EQUIVALENT AND QUALITY FACTOR IN RADIATION FIELD AROUND HIGH ENERGY ELECTRON ACCELERATORS IN FRASCATI. Pszona, S.; Mlicki, K.; Sernicki, J.; Ladu, M.; Pelliccioni, M.; Roccella, M. (Institute of Nuclear Research, Warsaw (Poland)). 1972. 14p. Dep. NTIS (U. S. Sales Only).

The dose equivalent and quality factor around electron accelerators was measured using different detectors. The following detectors were used: a recombination ionization chamber; a double detector system using an ionization detector and an organic scintillator; a tissue equivalent ionization chamber; an air equivalent ionization chamber; and a neutron detector of the Anderson–Braun type. Quality factors in stray mixed radiation around the 700 MeV and 370 MeV electron accelerators attain values between 3 and 5 according to the places of the measurements. (auth)

10075 (JPRS-57489) SOME CALCULATED AND EXPERIMENTAL DATA CONCERNING THE DEVELOPMENT OF SYNCHROTRONS WITH A STEADY-STATE FIELD IN THE ENERGY RANGE OF 35 TO 300 GIGAELECTRON-VOLTS. Doynikov, N. I.; Monoszon, N. A.; Rozhdestvenskii, B. V.; Sivkov, Yu. P.; Stolov, A. M.; Trokhachev, G. V. Translation of Russian report. 6p. NTIS.

Calculation data for the construction of synchrotrons with rotating superconducting electromagnets with steady-state (fixed) fields are presented as well as the results of experimental investigations of models of the elements of the accelerators. (auth)

10076 (KFK-1636) PARAMETER STUDY FOR A COIL AS AN ELECTRON RING COMPRESSOR. Steinbock, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1972. 82p. (In German). Dep. NTIS (U. S. Sales Only).

The present electron ring compressors which produce relativistic electron rings consist of a set of Helmholtz coils which allow only a repetition rate of several cycles/sec because of the complicated switching mechanism. For future accelerators a high repetition rate must be achieved for the sake of high intensity. It is shown that with only one single coil pair with a suitable winding distribution one may obtain a comparably good compression and simultaneously increase the repetition rate up to 1 cycle/sec by the possible use of continuous alternating current. The winding distribution must be chosen in such a manner that the magnetic field on the orbit fulfills the physical demands of the injection compression and extraction. The new compressor geometry which has the form of a flat tin is also studied for its eddy current behavior, its extraction properties and its collective instabilities. The power requirements are computed and compared with a conventional compressor. (25 references) (auth)

10077 (LA-DC-72-1297) ALIGNMENT PHILOSOPHY, DESIGN, AND TECHNIQUES USED AT LAMPF. Colston, E. W.; Hart, V. E. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 9p. (CONF-721046-4). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

This paper describes some of the more important alignment philosophies and techniques used to build the LAMPF Accelerator. The laser equipment used for alignment, the establishment of the 2,600 foot accelerator axis, the Alvarez section drift-tube alignment and some of the off-axis alignment techniques used are discussed. (auth)

10078 (LA-DC-72-1298) INSTALLATION AND ALIGNMENT OF LAMPF 201 MHz AND 805 MHz LINAC TANKS. Hart, V. E.; Colston, E. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 7p. (CONF-721046-7). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

Design considerations and alignment techniques used in the mounting and installation of the LAMPF Accelerator tanks are described. Extensive use of laser alignment equipment along with optical tooling and linear tooling tapes were used to position tanks in the beam channel. Assembly procedures used to reliably make 368 "one-shot" knife edge vacuum-rf joints on the side-coupled linac are also discussed. (auth)

10079 (LBL-1326) COLLECTIVE PHENOMENA IN ACCELERATORS. Sessler, A. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 9p. (CONF-721046-9). Dep. NTIS.

From Proton linear accelerator conference, Los Alamos, NM (10 Oct 1972).

A short review is presented on the collective modes of behavior of relativistic particle beams and collective methods of acceleration of particles such as the electron ring accelerator. (34 references) (W.H.K.)

10080 30 kV ION BEAM ACCELERATOR FOR EROSION STUDIES. Hurley, R. E.; Baker, P. N. (Central Research Lab., Sussex, Eng.). Nucl. Instrum. Methods; 105: No. 2, 387-9(1972).

A 30-kV ion beam accelerator for erosion studies is described, and the results of measurements with two types of ion source are given. The accelerator permits a well-defined finely focused ion beam to be uniformly scanned across targets for micromachining or low-energy implantation. (5 figures). (auth)

Auxiliaries and Components

10081 (JINR-P9-6585) THYRISTOR OPERATOR FOR HIGH FREQUENCY OSCILLATOR OF 680 MeV SYNCHROCYCLOTRON (JINR). Enchevich, I. B.; Maksimov, Yu. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The thyristor operator which controls the high frequency oscillator of the accelerating voltage at the JINR synchrocyclotron, is described. The operator momentum amplitude being 650 V, the spacing is 2 to 10, and the operator momentum repetition rate is 100 to 120 Hz. (auth)

10082 (LA-DC-72-1299) RIPPLE CURRENT AND FLUX IN MINERAL INSULATED MAGNETS. Schneider, E. J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 4p. (CONF-721046-8). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

A focusing or quadrupole magnet employing a solid iron core and wound with mineral-insulated (M. I.) conductor presents an impedance to the ripple voltage output of a power supply much different from the same magnet wound with a conventional-type conductor. This difference is due to the shorted-turn effect produced by the sheath of the M. I. conductor. Although its impedance is different, the attenuation of the ripple flux caused by the ripple current vs frequency appears to be of the same order as that of a similar magnet wound with a conventional-type conductor. This paper presents experimental data illustrating the described effect. (auth)

10083 (LA-DC-72-1300) LAMPF KLYSTRON REPAIR FACILITY. Tallerico, P. J. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 3p. (CONF-721046-11). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

Major and minor repairs on the 1¼ MW, 805 MHz LAMPF klystrons are being performed in-house. The repair facility and the processes and procedures used to effect these repairs are discussed. The minor repairs usually consist of cleaning the outside of a ceramic insulator and hi-potting the electron gun. The klystron is cut open for a major repair; one or more parts are re-

paired or replaced, the cathode is cleaned and recoated and the tube is reassembled, evacuated, baked out and reprocessed. Several of the more critical procedures such as the vacuum bakeout and cathode cleaning, coating and activation are discussed in some detail. The observed failure rates and mechanisms are presented for the klystrons and for several other high-power tubes which are used at LAMPF. Some of the hi-potting procedures and equipment have been used to reprocess the modified ML-8495 switching triodes which are used in the klystron modulators. Several of these triodes have been reprocessed at LASL to restore their original high voltage capabilities. The hi-plotting procedures for the triodes and klystrons are presented. Several triodes have exhibited excessive grid emission, and a procedure to heat the grid has been effective in these cases. (auth)

10084 MEASUREMENT WITH THE 9024-01 INSTALLATION OF THE PARAMETERS OF THE ELECTRON BEAM OF THE ACCELERATOR. Egorov, L. B.; Kostyleva, Yu. G.; Mysev, I. P.; Samoilov, P. S.; Khomyakov, A. M. Yadern. Priborostr.; No. 14, 147-59(1971). (In Russian).

The principles of the operation of the installation for the measurement of the energy, output, charge, current, and mean energy of the electron spectra and shape of the electron beam at energies from 0.3 to 20 MeV are examined. The results of measurements on the EG-5-E electrostatic accelerator are reported. (tr-auth)

Ion Sources and Injection and Extraction Systems

Refer also to abstract 10353.

10085 (BNL-17247) ION SOURCES FOR PROTON LINACS. Sluyters, T. (Brookhaven National Lab., Upton, N. Y.). [nd]. 15p. (CONF-721046-10). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

A review is presented on the present performance of the ion sources in the world's largest proton linacs installed in the following laboratories: National Accelerator Laboratory (Batavia, USA), Argonne National Laboratory (Chicago, USA), Rutherford High Energy Laboratory (Chilton, England), CERN (Geneva, Switzerland), Los Alamos Scientific Laboratory (Los Alamos, USA), Centre d'Etudes Nucleaire (Saclay, France), Institute for High Energy Physics (Serpukhov, USSR), Brookhaven National Laboratory (Upton, USA), and Institute of High Energy Physics (Tsukuba, Japan). (auth)

10086 (BNL-17248) OPERATION OF THE BNL 200 MeV LINAC. Batchelor, K. (Brookhaven National Lab., Upton, N. Y.). [nd]. 8p. (CONF-721046-2). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

The operation of the linac for the period from October 1, 1971, to August 31, 1972, at which time a major AGS failure caused an unscheduled shutdown of the AGS complex is outlined. Topics include overall operation, preinjector operation, low energy beam transport system, vacuum and water systems, controls, magnets and quadrupoles, rf system, power failures, and beam measurements. (W.H.K.)

10087 (JINR-P7-6668) ION SOURCES FOR PRODUCTION OF MULTICHARGED IONS FROM SOLID MATERIALS. Pasyk, A. S.; Tret'yakov, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Indirectly heated cathode sources of multicharged ions of solid materials have been developed for the three-meter cyclotron of JINR. The feed of the material into the discharge was realized by two methods: by the cathode sputtering of solids or by evaporation from a crucible. The ion sources worked in the pulse regime on the bench as well as in the cyclotron. Multicharged ions of Mg, Si, P, Ca and Zn were produced in the bench test from the ion source operating on vapors of these materials. Mg^{4+}, Si^{5+}, P^{5+}, Ca^{7+} and Zn^{10+} ions were accelerated in the cyclotron. The directly heated crucible was used. Multicharged ions of Mg, Si, Ca, Ti, Cu, Zn, Mo, Ta, W and Re were produced in the bench test from the ion source with the cathode sputtering. Ca^{7+}, Ca^{8+} and Zn^{10+} ions were accelerated in the cyclotron which were produced from this ion source. Some kind of noble gas was usually used as an auxiliary. (auth)

10088 (KHFTI-71-31) FORMING OF PRECISION BEAMS IN MULTISECTIONAL ELECTRON LINEAR ACCELERATORS. Artemov, V. I.; Grishaev, I. A.; Gugel', I. N.; Dem'yanenko, G. K.; Dovbnya, A. N.; Kornienko, E. V.; Mocheshnikov, N. I.; Peev, F. A.; Petrenko, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method of producing precision beams in electron linear accelerators is described. The method is based on the use of the coupling of radial and phase motion. The effects of high-frequency and current instabilities on the beam parameters were investigated. The method of measuring the beam emittance at the accelerator outlet at 2 BeV is reported. A plate with a set of narrow slots and detectors was used for the measurement. The experimental characteristics of the beam were compared with the calculated characteristics. (tr-auth)

10089 (KHFTI-71-32) CONSTRUCTION AND CHARACTERISTICS OF AN INJECTOR ACCELERATOR WITH STEPWISE CHANGE OF WAVE PHASE VELOCITY. Vishnyakov, V. A.; Bepoglazov, V. I.; Bondarenko, A. V.; Gurtovenko, P. G.; Gutnik, G. N.; Dombrovskii, S. V.; Evseev, G. I.; Kolosov, V. I.; Rudenko, A. P.; Fainzil'berg, S. D. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 22p. (In Russian). Dep. NTIS (U. S. Sales Only).

The construction and experimental characteristics of an injector accelerator with stepwise change of the wave phase velocity from 0.7 c to 1 c are described. The intensity of the accelerating field varies from 40 to 80 kV/cm at an energy of 5 MeV guaranteeing forming of the electron bunch of the phase dimension from 5 to 10°, for injection into the 2-GeV Kharkov linac. (tr-auth)

10090 (LA-DC-72-1438) STATUS OF THE LAMPF H^- INJECTOR. Allison, P. W.; Meyer, E. A.; Mueller, D. W.; Stevens, R. R. Jr. (Los Alamos Scientific Lab., N. Mex.). [nd]. 20p. (CONF-721046-20). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

Simultaneous acceleration of H^+ and H^- beams at LAMPF is planned, with the H^- beam to be used as an independently controlled source of 800-MeV protons for use in nucleon physics investigations. As such the H^- design intensity is low, variable up to 1.67-mA peak (100-μA average). Initial operation of the H^- injector, expected in January, will be about 10% of this level. Research on H^- sources yielding up to 2.5 mA is presented, along with details of the injector installation. (auth)

10091 (LA-DC-72-1442) RMS EMITTANCE AND THE LAMPF BEAM. Mueller, D. W. (Los Alamos Scientific Lab., N. Mex.). [nd]. 2p. (CONF-721046-21). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM (10 Oct 1972).

The LAMPF preinjector can, with the very careful adjustment, produce a beam with almost constant current density, uniform emittance spread across the beam, and good linearity in divergence. Intensity as a function of velocity difference from the local centroid velocity at any point is roughly Maxwellian. The rms emittance has obvious physical significance if we idealize this special case. The velocity term of the rms emittance is the square of the rms velocity deviations from the local velocity centroid and is therefore proportional to the local temperature, i.e., that for a macroscopically small element of volumn of the beam. The phase space can thus be populated in a physically significant way and the difficulty of assigning envelope values of r and $\dot{r}$ required by the KV concept is eliminated. (auth)

10092 ELECTRON INJECTORS FOR LINEAR ACCELERATORS. Tronc, D. (Thomson-CSF, Orsay, France). Nucl. Instrum. Methods; 105: No. 2, 335-47(1972).

The effects of the input electron energy, of the modulation and drift space choice for a prebunching device, of the field and length choice for a first "long" cell, and of the accelerating "synchronous" structure itself are computed; these calculations lead to the evaluation of the gun voltage effect on the bunching performances, to a simple model describing the prebunching with space charge effect, and to the improvement in performance—together with very low sensitivity to parameter variations around the design values—obtained with a first asynchronous cell. Electron injector designs are presented. (15 figures, 3 tables). (auth)

10093 DESIGN OF THE EXTRACTION SYSTEM FOR THE AEG-COMPACT CYCLOTRON. Liesem, H. (Gesellschaft fuer Strahlen und Umweltforschung, Frankfurt am Main). Nucl. Instrum. Methods; 105: No. 2, 329-32(1972).

The extraction system of the AEG Compact Cyclotron consists of an electrostatic deflector and a subsequent magnetic channel. Design criteria for both elements are described. (5 figures, 2 tables). (auth)

10094 PRINCIPLE FOR EFFICIENT PRODUCTION OF SHORT BURSTS OF IONS WITH SMALL ENERGY SPREAD OUT OF A FINITE EMITTANCE BEAM. Zieher, K. W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 105: No. 2, 221-9(1972).

It is well known that with a single high-frequency transverse electric field deflector one cannot get shorter ion bursts than allowed by the relation $\Delta W \Delta T \geq \Delta p_y \Delta y$, where the monoenergetic beam has a transverse momentum spread Δp_y and transverse width Δy, ΔW and ΔT being the energy spread and the duration of the bursts, respectively. The use of two energy modulators and a momentum analyzing magnet can overcome this barrier. An analysis of the longitudinal phase area occupied by the bursts produced by this method is given. (3 figures, 2 tables) (auth)

10095 COMPACT PULSER FOR RADIO FREQUENCY ION SOURCES. Hanna, N. N. (Egyptian Atomic Energy Establishment, Cairo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-19: No. 3, 480-5(Jun 1972).

From 13th scintillation and semiconductor counter symposium; Washington, DC (1 Mar 1972). See CONF-720306.

A simple and efficient transistorized pulser for pulsing the rf power supplied to ion sources is described. The pulsing transistor is off during the quiescent period, and no pulse transformers are used. Accurately timed rf pulses of 600 W peak power are obtained, and the pulser consumes about 1 W. Pulse durations in the range 1 μs to 10 ms at duty cycles of up to 0.5 are achieved. Time jitter is less than 10 ns and can be reduced to 1 ns by using stabilized supply voltages. This is the first time in which transistors are used in pulsing such high-power rf ion sources with reasonably high timing accuracy. Criteria for switching the highest rf power from a given pulser are given. (auth)

Ion Optics and Field Calculations

Refer also to abstract 10107.

10096 (BNL-17224) INDUCED EMFS IN TWO-DIMENSIONAL FIELDS. Beth, R. A. (Brookhaven National Lab., Upton, N. Y.). 1972. 4p. (CONF-720908-19). Dep. NTIS.

From 4th international conference on magnet technology; Upton, NY (19 Sep 1972).

For the case of two-dimensional fields and cylindrical sheet coils, detailed calculations can be made because both the fields and the coils can be resolved into multipole or harmonic components. It is shown that a carefully made 2n-pole winding enclosing an aperture can be used: (1) on open circuit, as a search coil to measure the 2n-pole field component entering the aperture from outside the coil; and (2) on closed circuit, as a passive self-powered shield to oppose the intrusion into the aperture of any 2n-pole field component from outside and, if the coil is superconducting, to exclude that component entirely. The "two potential" complex formulation for two-dimensional fields facilitates the analysis. Expressions are also derived for the self and mutual inductances of cylindrical sheet coils. (auth)

10097 (BNL-17257) CALCULATIONS AND MEASUREMENTS ON REDUCTION OF THE ENERGY SPREAD AND THE VARIATION IN MEAN ENERGY OF THE 200-MeV LINAC BEAM AT BROOKHAVEN. Batchelor, K.; Chasman, R.; Fewell, N. (Brookhaven National Lab., Upton, N. Y.). [nd]. 15p. (CONF-721046-1). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

By varying the synchronous phase angle from $-32°$ at injection to $-8°$ at 200 MeV, calculated improvements of 2 and better were obtained for energy spread and sensitivity of mean output energy to rf phase and amplitude errors in the BNL 200-MeV linac. Measurements done so far indicate improved longitudinal beam performance, but better tank set-up procedures are necessary for more accurate confirmation of the calculated values. Furthermore, lower operating fields ease the burden on the rf power system without causing loss in beam transmission. The number of short-term breakdowns in the modulator system has been reduced by an order of magnitude. (W.H.K.)

10098 (BNL-17258) DEPENDENCE OF TRANSVERSE EMITTANCE GROWTH OF THE QUADRUPOLE FOCUSSING STRENGTH IN THE BROOKHAVEN 200 MeV LINAC. Batchelor, K.; Chasman, R.; Fewell, N.; Witkover, R. (Brookhaven National Lab., Upton, N. Y.). [nd]. 24p. (CONF-721046-3). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

Beam emittance growth factors were studied in the quadrupole focusing elements in the first 10 MeV tank of the Brookhaven 200 MeV linac to explain the observed emittance growth factors of 2 to 3 in the linac. Observed and calculated transverse emittance growth of a high intensity beam in the 10 MeV section showed little dependence on the strength of the transverse focusing. It is concluded that efforts to improve the transverse beam quality should be directed towards the design of more intricate buncher schemes resulting in a smaller longitudinal emittance at injection. (W.H.K.)

10099 (BNL-17398) HYSTERESIS LOSS IN IRON-SHIELD DIPOLE MAGNET. Dahl, P. F.; McInturff, A. D.; Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). 16 Nov 1972. 4p. Dep. NTIS.

Hysteresis losses during pulsed operation of a small superconducting dipole model magnet, with and without an iron shield, have been measured in order to estimate iron losses and compare them with losses predicted from magnetization measurements. (auth)

10100 (CERN-Trans-72-15) INTERACTION OF AN INTENSE BEAM WITH THE CAVITIES OF THE ACCELERATING STATIONS AT TRANSITION. Balbekov, V. I.; Pashkov, P. T. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN, Geneva), from report IFVE-SKU-71-72. 15p. Dep. NTIS (U. S. Sales Only).

An examination is made of the phase oscillations of particles in a circular accelerator with strong focusing, at an energy close to the transition energy, and with a high beam intensity. It has previously been shown that once the critical energy has been passed, modulation of the length and width of the bunches may occur. This is caused by the longitudinal Coulomb field of the beam, which lowers the frequency of synchrotron oscillations in the below-transition region and increases the frequency in the above-transition region. The sharp change in focusing leads to a mismatch of the bunches in relation to the shape of the "bucket," i.e., to a modulation of their dimensions. The voltage induced by the beam on the accelerating cavities influences the frequency in a similar manner, and consequently may also be a cause of the modulation of the bunch dimensions. In the present work, these effects are considered together. It would not be quite correct to consider them separately, since both effects are substantially non-linear, and may mutually reinforce or attenuate each other. (auth)

10101 (JINR-P9-6680) LONGITUDINAL COMPRESSION OF AN ELECTRON RING IN THE DELAYED ELECTROMAGNETIC WAVE. Bogdanova, S. N.; Gavrilova, Z. G.; Reshetnikova, K. A. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

Possible longitudinal compression of an electron beam in the electromagnetic wave, moving in step with the ring, is considered. It is shown that by amplification of the bunching effect, e.g., by the parametric resonance, the oscillation amplitude (in the longitudinal direction) decreases less than by ordinary adiabatics. (auth)

10102 (JINR-P9-6700) PARAXIAL THEORY OF INTENSE RELATIVISTIC ELECTRON BEAMS. Parish, D.; Ryl'tsev, P. I.; Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1972. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some aspects of the motion of high-current electron beams near the axis are considered taking into account the effect of the initial azimuthal scattering of particle velocities, the intrinsic current, and the magnetic self-field of a beam. The results of the estimating calculations are presented via graphs. (auth)

10103 (LA-5112) PERMISSIBLE MULTIPOLE FIELD COMPONENTS IN QUADRUPOLE MAGNETS. Vogel, H. F. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

The rms multipole flux density sum useful for engineering specifications is derived from a set of permissible multipole potentials. (auth)

10104 (LA-DC-72-1241) TRANSVERSE BEAM MATCHING USING WIRE SCANNERS. Crandall, K. R. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 3p. (CONF-721046-5). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

In order to avoid excessive beam loss in the 805-MHz portion of LAMPF, it is necessary to match the beam emittance to the acceptance of the linac. This is achieved by minimizing the os-

cillation amplitude of the rms beam widths as measured by wire scanners. (auth)

10105 (LA-DC-72-1251) MEASUREMENTS AND CALCULATIONS OF FIELD DISTRIBUTIONS IN SHORT HELICAL RESONATORS. Tombrello, T. A.; Jancaitis, K. S. (California Inst. of Tech., Pasadena); Bendt, P. J.; Erkkila, B. H.; Stokes, R. H. (Los Alamos Scientific Lab., N. Mex.). [nd]. 32p. (CONF-721046-12). Dep. NTIS.

From Proton linear accelerator conference; Los Alamos, NM. (10 Oct 1972).

The simple conducting sheath model of the helical waveguide accurately describes the properties of both helical transmission lines and long helix resonators. However, the boundary conditions at the ends of a resonator are not satisfied exactly for the coupled TE–TM mode solutions that arise in the sheath model treatment. The termination effects become more important for shorter resonators, and measurements of field distributions and resonant frequencies of half-wavelength resonators show large disagreements with simple sheath model calculations. Because of the interest in resonators of this type for low velocity linear accelerator structures, an experimental and theoretical study of several short resonator geometries was made. A new calculational technique has been developed to describe more accurately the boundary conditions imposed by simple shorting planes. The technique is also capable of simulating other termination conditions, and allows the effect of variable pitch to be included. Comparisons have been made with measured electric and magnetic field distributions and resonant frequencies for a variety of half-wavelength designs. These comparisons demonstrate that the new method of calculation is a significant improvement over the simple sheath model. (auth)

10106 (LBL-1072) TRANSVERSE TWO-STREAM INSTABILITY IN THE PRESENCE OF STRONG SPECIES-SPECIES AND IMAGE FORCES. Laslett, L. J.; Moehl, D.; Sessler, A. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 21p. (CONF-721029-3). Dep. NTIS.

From third all-union conference on high-energy particle accelerators; Moscow, USSR (2 Oct 1972).

The theory of coherent transverse oscillations of two particle species is extended to include strong species–species and image forces. It is shown that in general the species–species force can considerably alter the instability threshold. Conversely, it is shown that the limit on the performance of an electron ring accelerator imposed by the requirement of stable ion electron oscillations is not significantly improved by the inclusion of images. (auth)

10107 (UCRL-Trans-1480) INFLUENCE OF METALLIC SURFACES ON THE STABILITY AND FOCUSING OF RELATIVISTIC ELECTRON RINGS. Bonch-Osmolovskii, A. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by G. Brodell (Univ. of California, Berkeley. Lawrence Berkeley Lab.), from report JINR-P9-6318. 16p. Dep. NTIS.

The possibility of depressing the radiative instability and also focusing effects when compressing the relativistic electron ring in the vicinity of metallic surfaces is considered. The nature of the curvature effect in the effective index of the focusing field decay is discussed. (auth)

10108 INTERACTIVE COMPUTER GRAPHICS APPROACH TO BEAM OPTICS DESIGN. Davies, B. W. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Instrum. Methods; 105: No. 3, 477-82(1972).

An interactive computer graphics program for the study of beam optics systems is described. The program can be used over a wide range of beam energies, and includes several facilities particularly relevant to low energy systems. Details of the modes of interaction between the user and the computer are given and an example is quoted to illustrate the operation of the program. (auth)

Storage Rings

10109 (BNL-17371) $\bar{p}p$ OPTION AND WHIPLASH. Mes, H. (Brookhaven National Lab., Upton, N. Y.). [nd]. 6p. Dep. NTIS.

An experimental setup is proposed and the interaction rate and luminosity are approximated for $\bar{p}$ annihilation studies at low energies in ISABELLE. (W.H.K.)

Experimental Facilities

Refer also to abstracts 9616, 9735, and 10109.

10110 (BNL-17429) DYNAMIC SURVEY OF A BEAM TRANSPORT SYSTEM. Claus, J. (Brookhaven National Lab., Upton, N. Y.). 20 Nov 1972. 4p. Dep. NTIS.

A method for obtaining the geometry of a beam transport system is described. It depends on changing the strengths of the components in a known way and observing the corresponding displacements of the beam. (auth)

10111 (CERN-Trans-72-12) CHANNEL SYSTEM FOR NEGATIVE PARTICLES WITH A MOMENTUM OF UP TO 40 GeV/c. Grachev, M. I.; Gubrienko, K. I.; Eremenko, E. V.; Kartashev, V. P.; Kotov, V. I.; Samoyulov, A. V.; Seleznev, V. S.; Khodyrev, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by B. Hodge (CERN), from report IFVE-OP-70-98. 18p. Dep. NTIS (U. S. Sales Only).

A channel system is described for negative particles with momenta up to 40 GeV/c produced in the accelerator of the Institute for High-Energy Physics. A procedure is described for studying the characteristics of particle beams in these channels, and the basic parameters of the channels are presented. (auth)

10112 (INR-1396) PREPARATION OF TRITIUM GAS, TRITIATED WATER, AND TRITIUM TARGETS. Horski, Jozef (Institute of Nuclear Research, Warsaw (Poland)). 1972. 42p. (In Polish). Dep. NTIS (U. S. Sales Only).

A method for production of tritiated water and tritium-titanium or tritium-zirconium targets is elaborated. The method consists of: activation of a lithium-aluminium alloy, separation of the tritium by heating, and oxidation on the CuO to tritiated water or absorption of tritium on titanium or zirconium. The experiments were carried out in Tritium and Carbonium-14 Laboratory of Radioisotopes Production and Distribution Centre of the Institute of Nuclear Research in Swierk. (auth)

10113 (LA-5084) MAGNETIC MEASUREMENTS ON THE LASL PROTOTYPE MAGNET. Dunwoody, W.; Rolfe, R.; Spencer, J.; Stearns, R.; Tanaka, N.; Thomason, M. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 12p. Dep. NTIS.

A small dipole magnet has been designed and constructed for use as a prototype for the kinds of magnets to be used with the High Resolving Power Spectrometer (HRS) and the Energetic Pion Channel and Spectrometer (EPICS) facilities currently under construction at the Los Alamos Scientific Laboratory. Because of the wide range in uniform field strengths and the high degree of homogeneity which is required in these magnets, a more versatile method than pole face shims or homogenizers was considered necessary. A set of corrective current elements, called H_t-windings, were introduced inside the pole pieces of the magnet to provide dynamic correction of field inhomogeneities in the uniform field region. By successively varying these currents and plotting the resulting field distribution, $B_y(x)$, it was possible to reduce magnetic field variations of a few parts in 10^3 in the initial median plane distribution to a few parts in 10^5 over a range of induction fields of $B_0 = 4$ to 17 kG. These initial results indicate that field homogeneities significantly better than 1 part in 10^5 should be possible with the appropriate number and distribution of H_t-current elements. (auth)

10114 (LUSY-7210) WIDE ANGLE SPECTROMETER AT THE CERN-ISR: A BRIEF DESCRIPTION OF THE EXPERIMENTAL ARRANGEMENT AND OF THE PROCEDURES FOR DATA ACQUISITION AND ANALYSIS. Paper 20. (Lund Univ. (Sweden). Dept. of Physics). [nd]. 68p. Dep. NTIS (U. S. Sales Only).

The experimental arrangement and data treatment for the British–Scandinavian experiment R203 at the CERN ISR are described. The wide angle spectrometer is designed to collect data on inclusive particle production in p + p collisions at wide angles (29 to 30° in the center-of-mass system). It has also been designed to meet the requirements of a quark search (high rejection ratio required). The set-up, which consists of two magnets, three hodoscopes, and six magnetostrictive spark chambers, is described. Also, the on-line computer, data collection, and data treatment are discussed. (W.H.K.)

10115 (LYCEN-7230) ANALYSIS OF A DATA ACQUISITION SYSTEM FOR NUCLEAR PHYSICS EXPERIMENTS. DESCRIPTION OF THE SYSTEM OF THE LYON INSTITUTE OF PHYSICS: GRAPHICAL TREATMENT OF HISTOGRAMS. Bouche, R.; Cheval, J.-L.; Jambon, R.; Gimond, G. (Lyon Univ. (France). Institut de Physique Nucleaire). 2 Jun 1972. 25p. (In French). Dep. NTIS (U. S. Sales Only).

An analysis of the complete data handling system for numerical information from nuclear physics experiments demonstrates that a maximum exploitation of the system requires a certain degree of simultaneity in the operations of the different elements of the

system (acquisition, prehandling, handling of spectra etc.). The system used to handle data from the synchrocyclotron of the Institute of Physics at Lyon is described (principally the TROL description language). Problems concerning the graphical handling of the spectra are presented. (France)

10116 ELECTRON SCATTERING APPARATUS AT THE MAINZ 300 MeV ELECTRON LINEAR ACCELERATOR. Ehrenberg, H.; Averdung, H.; Dreher, B.; (and others) (Univ., Mainz). Nucl. Instrum. Methods; 105: No. 2, 253-63(1972). (In German).

A general survey and a comprehensive description of the most significant features of the facilities for electron scattering experiments at the Mainz 300-MeV Linear Accelerator are given, along with a list of literature where more detailed information on certain subjects can be found. The accelerator provides energies between 80 and 300 MeV. Scattering angles are available up to 160°; a momentum transfer region up to 3.0 fm^{-1} is thus available. The overall experimental resolution is 0.1%. Cross sections down to 10^{-34} cm^2/sr can be measured. The main features of the apparatus are an achromatic magnet system with 90° deflection, a double-focusing spectrometer, a 75-channel double coincidence detector ladder spanning a 7% final energy width, and an on-line data acquisition system, together with several beam stabilizing and monitoring systems. (auth)

10117 HIGH-RESOLUTION DETECTION SYSTEM FOR SHORT-LIVED GASEOUS ACTIVITIES. Esterl, J. E.; Sextro, R. G.; Hardy, J. C.; Ehrhardt, G. J.; Cerny, J. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 97: No. 2, 229-33 (1 Dec 1971).

A fast gas-sweeping system has been developed which enables activities to be transported up to 5 m from the target position in 50 to 100 ms. It has been used along with a cooled semiconductor-counter telescope to obtain delayed-proton spectra in which the energy resolution was limited to 45 keV by kinematic effects. The remote counting location also permits use of a Ge(Li) detector without fear of radiation damage. Several different high-yield target configurations are described, including a sulfur target that is useful for prolonged high-intensity bombardments. (auth)

10118 MEASUREMENT OF COHERENT BREMSSTRAHLUNG SPECTRA AT THE ELECTRON LINEAR ACCELERATOR. Gorbenko, V. G.; Zhebrovskii, Yu. V.; Kolesnikov, L. Ya.; Rubashkin, A. L. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 757-60(May 1972). (In Russian).

The experimental data are reported on the spectrum measurement of coherent bremsstrahlung from the diamond single crystal at the linear accelerator of the Physicotechnical Institute of the Ukrainian Academy of Sciences with the maximum electron energy of 2 GeV by means of registrating the secondary electrons. The description of the experimental installation and the parameters of the magnetic spectrometer of the secondary electrons and detected apparatus are presented. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Refer also to abstract 11093.

Cosmic Radiation

Refer also to abstracts 9284, 9737–9740, 9744, 9745, 9747, 10433, 10434, 10446–10448, 10460–10466, 10470, 10537, 10539, 10540, 10561, 10644, and 11183.

10119 RESIDUAL COSMIC RAY MODULATION AT THE 1954 SOLAR MINIMUM. Thomson, D. M. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 20: No. 12, 2196-7(Dec 1972).

Analysis of the anomalous solar diurnal variation in cosmic rays at the 1954 solar minimum yields an estimate of the residual solar modulation present at the time. The data are consistent with a modulation parameter M in the range $0.6 < M \lesssim 1.5$ GV. Reasons are given for preferring a value in the upper half of this range. (auth)

10120 COSMIC RAYS AND NUCLEAR INTERACTIONS AT HIGH ENERGIES. Skobel'tsyn, D. V. (ed.). Lebedev Physics Institute Series, Volume 46. New York; Plenum Publishing Corporation (1971). 233p. $29.50.

Translated from Russian by Frank L. Sinclair.

Separate abstracts are prepared for the nine papers included. (C.E.S.)

For abstracts of individual papers see: 9737–9742, 10121, 10122, and 10455.

10121 EXTENSIVE AIR SHOWERS AND INTERACTION OF PARTICLES WITH ENERGIES ABOVE 10^{13} eV. Nikol'skii, S. I. Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 91-139(1971).

An analysis is given of the experimental data on extensive air showers and other phenomena due to cosmic radiation of ultra-high energy. The energy spectrum and composition of primary cosmic radiation are discussed. (F.S.)

10122 INVESTIGATION OF THE NUCLEAR COMPONENT OF COSMIC RAYS IN A PERIOD OF MINIMUM SOLAR ACTIVITY. Kurnosova, L. V.; Logachev, V. I.; Razorenov, L. A.; (and others). Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 202-28(1971).

Prolonged observations of changes in intensity of different groups of nuclei in cosmic radiation during a period of minimum solar activity were made with Cherenkov counters mounted on long-lived satellites. Several cases of increased nuclear intensity, caused by an increase of heavy nuclei were found and were thought to be connected with the generation of nuclei on the sun. Variations due to modulation of the primary galactic cosmic rays were found to be small in a period of minimum solar activity. The flux of superheavy nuclei with charge $Z > 30$ were grouped around 10^2. The ratio of the abundance of nuclei of different elements in cosmic rays and in the universe ceases as the ratio increases up to $Z \approx 40$. (F.S.)

10123 TRANSPORT PROPERTIES OF CHARGED PARTICLES IN ONE DIMENSION IN RANDOM ELECTRIC FIELDS. Lerche, I. (Univ. of Chicago). Astrophys. J.; 178: No. 3, 819-35(15 Dec 1972).

First-order smoothing theory is a commonly used approximation in obtaining estimates of the transport properties of charged particles in turbulent electric and magnetic fields. In order to demonstrate as succinctly as possible some of the changes introduced into the transport equations when the first-order smoothing approximation replaces a statistically exact description of the turbulent processes at play, the problem of one-dimensional charged-particle evolution under a turbulent electric field is discussed. The behavior of charged particles in a one-dimensional turbulent electric field is discussed using a statistical pair of equations obtained by invoking the quasi-normality hypothesis. It is demonstrated how the first-order smoothing approximation is obtained from this pair of equations. The behavior of charged particles in a one-dimensional turbulent electric field is discussed using a Gaussian distribution for the electric field. Comparison of the behavior of the three problems indicates several similarities and several differences. (W.D.M.)

10124 COSMIC-RAY EVOLUTION DUE TO INTERACTIONS WITH SELF-EXCITED PLASMA WAVES. Lee, M. A. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Astrophys. J.; 178: No. 3, 837-55(15 Dec 1972).

Kinetic equations describing a relativistic plasma embedded in a uniform ambient magnetic field were used to investigate the time evolution of the cosmic-ray momentum distribution due to interactions between the cosmic-ray particles and their self-excited waves. Within the cosmic-ray lifetime there is negligible change in the cosmic-ray energy spectrum, but for particles with energy less than about 20 GeV there occurs a marked reduction of the cosmic-ray streaming velocity to a value of the order of, but greater than, the Alfvén speed, the exact value depending sensitively on the timescale for ion–neutral collisions. (auth)

10125 MODULATION OF COSMIC-RAY ELECTRONS. Earl, J. A. (Univ. of Maryland, College Park). Astrophys. J.; 178: No. 3, 857-62(15 Dec 1972).

The origin and time variations of the steep spectrum of electrons observed below 20 MeV may be explained by a simple model in which the spectrum of interplanetary cosmic rays is decomposed, at low energies, into two independently varying components. (auth)

10126 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16–25, 1971. VOLUME 6. Hobart, Australia; International Union of Pure and Applied Physics (1971). 467p. (CONF-710807-(Vol.6)).

Separate abstracts were prepared for the 47 papers presented. (W.H.K.)

For abstracts of individual papers see: 9617, 9744–9750, 10127–10141, 10433, 10434, 10446–10448, 10460–10466, 10485, 10486, 10537–10540, 10561, 10578–10580, 10644, and 10645.

10127 SOME ARGUMENTS IN FAVOUR OF THE CONVENTIONAL EAS MODEL REVISION. Kalmykov, N. M.; Khristiansen, G. B.; Fomin, Yu. A. (Moscow State Univ.). pp 2074-86 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

There exist experimental data that cannot be explained by the ordinary CKP model. It is shown that increasing nucleon inelasticity and the sharp rise of the multiplicity in the region above 10^4 GeV may adjust the theory to the experiment. The possibility of studying the individual EAS cascade curves by the form of the Cherenkov pulse is considered. (auth)

10128 SPATIAL DISTRIBUTION OF THE ELECTRON-PHOTON SHOWER POWERS IN ISOTHERMIC ATMOSPHERE. Guzhavin, V. V.; Ivanenko, I. P.; Paskhalov, Yu. I. (Moscow State Univ.). pp 2087-96 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The first three moments of the spatial distribution functions of electrons with energies higher than E in the electron-photon showers with energy E_0 developing in homogeneous and isothermic atmospheres are calculated to the approximation of small multiple scattering angles omitting ionization loss. When calculating the moments all exponents over t of the form $\exp[\lambda (s + n)t]$, $i = 1,2$ are included. The moments obtained are used to plot the spatial distribution functions of shower particles for various values of energy ratio E/E_0 and depths t. (auth)

10129 ELECTRON AND MUON STRUCTURE FUNCTIONS IN EAS OF ENERGIES 10^{15} TO 10^{17} eV. Khristiansen, G. B.; Vedenee, O. V.; Kulukov, G. V.; Nazarov, V. I.; Solovjeva, V. I. (Moscow State Univ.). pp 2097-2108 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The experimental data concerning the electron and muon of energies ≥ 10 GeV structure functions are presented. (J.F.P.)

10130 MUON COMPONENT OF EAS NEAR THE SHOWER AXIS. Iliyna, N. P.; Kalmykov, N. N.; Khrenov, B. A.; Khristiansen, G. B.; Jarochkina, Z. V. (Moscow State Univ.). pp 2109-21 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The experimental results on the muon component of EAS obtained with the help of muon detectors of the large Moscow University

installation are presented. The lateral distribution of muons of energies E ≥ 10 GeV near the shower axis (distances r ≤ 20 m) was obtained in EAS of sizes Ne = 4.5 · 10^5 and N_e = 1.2 · 10^6 and of various age parameter S. In the individual shower the lateral distribution of muons near the shower axis fluctuates in a correlation with the age parameter S of EAS. The exponent of the lateral distribution presented in a form $\rho_\mu(r) \sim r^{-h}$ varies from n = 0.2 (S ≥ 1,2) to n = 1 (S < 1,0) for distances r ≤ 20 m. The mean value of the exponent n is n = 0.36 ± 0.04 for EAS of sizes Ne = 4 to 10(10)^5. The investigation of the muon component of EAS at the depth of 40 hg.cm^{-2} underground ($E_\mu \geq 10$ GeV) was continued with the help of two muon detectors. (auth)

10131 RESULTS OF STUDY OF THE VERTICAL MUONS ENERGY SPECTRUM WITH ENERGIES $5 \times 10^{11} \leq E\mu \leq 5 \times 10^{12}$ eV. Khristiansen, G. B.; Vedeneev, O. V.; Nechin, Y. A. (Moscow State Univ.). pp 2122-31 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Experimental results on muons at a depth of 40 mwe underground were analyzed on the basis of statistical material recently received in Moscow University. These results were obtained by the "ionization burst" method with horizontal rows of ionization chambers and G-M counters. The energy spectrum of the vertical muons and the muon "photonuclear" interaction were investigated. The experimental spectra of showers with Ne ≥ 3.2 · 10^3 produced by the muons of energies $E_\mu \geq 5 \cdot 10^{11}$ GeV (zenith angles ≤45°) were compared with the calculated spectra of the different origin of muons. The experimental results are in contradiction with $\pi \rightarrow \mu$ and $K \rightarrow \mu$ decay ($K/\pi = 0.4$) and there is the additional mechanism, for example 2% direct muon production (relative to secondary particles of the same energy). Showers registered by several rows of ionization chambers and counters were selected from all other events. Those showers considered as photonuclear interactions of muons produced spectra harder than spectra of electron-photon showers. It might be explained if photonuclear cross section of muons increases with energy in the region $E_\mu > 5 \cdot 10^{11}$ eV. (auth)

10132 EAS ACCOMPANIMENT OF HIGH ENERGY MUONS. Aseikin, V. S. (Lebedev Inst. of Physics, Moscow); Erlykin, A. D.; Kukichenko, A. K.; (and others). pp 2132-41 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The EAS accompaniment of muons with energy $E_\mu > 0.5$ TeV was studied by the Tien-Shan complex installation. High energy muons ($E_\mu \geq 0.1$ TeV) were observed by an ionization calorimeter at 20 mwe depth from the center of the EAS installation. The latter consists of a GM array and a scintillator array in the center and also two points at 20 and 70 m from center. The data on low energy muon density were obtained by means of underground hodoscope arranged up to 70 m from the center. As calculations show, the probability that muons with $E_\mu \geq 10^{11}$ eV are accompanied by showers with $N_e \sim 10^4$-10^6 is sensitive to the primary spectrum. The experimental results based on about 700 hours were analyzed with respect to a composition of primary cosmic rays and nucleon-nuclei interaction at the energy ≥100 TeV. (auth)

10133 ENERGY SPECTRUM OF VERTICAL COSMIC MUONS. Erlkin, A. D.; Kulichenko, A. K.; Machavariani, S. K.; Maznichenko, S. S.; Meshkov, E. A. (Lebedev Inst. of Physics, Moscow). pp 2142-51 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Detailed investigations of vertical cosmic muons were performed with the underground ionization calorimeter at Tien-Shan station. The installation had operated above 2200 hours. For this period of time about 2000 cascades with $E_\mu > 1$ TeV were registered. The analysis of the obtained data shows that the energy spectrum of vertical muons can not be described with single power law over the interval of energy 0.3 to 10 TeV. The muon energy spectrum has the best fit with spectrum $dF/dE_\mu = B \cdot E_\mu^{-2.7} [(E^*/E_\mu + E^*)+R]$ where R = 0.02 for $E_\mu > 1$ TeV. (auth)

10134 ELECTRON AND MUON NUMBER SPECTRA OF EXTENSIVE AIR SHOWERS AT THE ALTITUDE 3340 m A. S. L. Aseikin, V. S. (Lebedev Inst. of Physics, Moscow); Benko, D.; Kabanova, N. V.; (and others). pp 2152-63 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Electron and muon number spectra of extensive air showers were investigated on Tien-Shan installation. The electron number spectrum of $N_e = 10^5 + 3.10^6$ and the muon number spectrum of $N_\mu = 5.10^3 + 5.10^4$ with muon energies $E_\mu > 5$ GeV can not be represented by power laws with constant exponents. These exponents change at about $N_e = (7 + 10) \cdot 10^5$ and $N_\mu = 2.5 \cdot 10^4$. The primary energy spectrum in the range $5.10^{14} + 5.10^{15}$ eV was recalculated from these two experimental spectra. (auth)

10135 LATERAL DISTRIBUTIONS OF THE PARTICLE DENSITIES AND OF CERENKOV LIGHT OF EAS AT SEA LEVEL. Egorov, T. A.; Kolosov, V. A.; Krasilnikov, D. D.; (and others) (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). pp 2164-71 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The sea level lateral distributions of the particle densities and of Cherenkov light of EAS at its far periphery obtained at Yakutsk EAS complex array are presented. The lateral distribution of a scintillator density at the core distances 100 to 700 m for a shower with $N = 10^8$ is consistent with NKG-function for age parameter S = 1.23 when muon and photon components of the shower are taken into account. The lateral distribution of Cherenkov light flux at the core distances 200 to 600 m has a form of $Q(R) \propto R^{-1.64 \pm 0.15}$ for shower size interval $10^7 + 10^8$ particles at sea level. The scaling factor of the sea level shower size to primary particle energy is (7.6 ± 1.9) · 10^9 eV per particle for a shower size interval of 10^7 to 10^8 particles. (auth)

10136 POSSIBILITY OF MEASURING THE NUCLEAR COMPOSITION OF PRIMARY COSMIC RAYS IN THE UH ENERGY RANGE. Volovik, V. D.; Zalyubovskii, I. I.; Lazurik-Eltsufin, V. T.; Chekhutsky, G. A.; Shmatko, E. S. (Kharkov State Univ.). pp 2172-80 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A method of determining the nuclear composition of primary cosmic particles in the energy range of 10^{17} to 10^{18} eV is proposed. The technique is based on the fact that in the hydro-dynamic model the EAS path produced by a nucleus with its mass number A up to the development maximum is shorter than that of the same energy produced by a proton. The calculation results show that the determination of the relative H- and He-contents in the primary cosmic rays over the energy range of more than 10^{17} eV is allowed by the given method. (Australia)

10137 STUDY OF RADIO EMISSION WITH THE FREQUENCY OF 30 MHz FROM EXTENSIVE AIR SHOWERS AT THE MOSCOW STATE UNIVERSITY ARRAY. Khristiansen, G. B.; Atrashkevitch, V. B.; Vedeneev, O. V.; Prosin, V. V. (Moscow State Univ.). pp 2181-93 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The lateral distribution of radio emission at a frequency of 30 MHz from EAS is studied. The geomagnetic mechanisms and correlations with the age parameter and total muon to total electron number ratio are discussed. (J.F.P.)

10138 ALTITUDE VARIATIONS IN EAS IN THE UPPER ATMOSPHERE. Antonov, R. A.; Ivaneko, I. P.; Samosudov, B. E.; Tulinova, Z. I. (Moscow State Univ.). pp 2194-2200 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The data on the altitude variations in EAS obtained using airborne equipment are presented. The equipment included 22 scintillation counters arranged in the fuselage and wings of aircraft (twenty 0.07 m^2 counters and two 0.25 m^2 counters) and a spark chamber. The distance between the mostly spaced counters was 34 m. The experimental data agree better with calculation on the assumption that at energies of ~10^3 TeV an appreciable portion of interactions occurs with fairly strong energy fractionation. The data on the spatial distribution of the shower particles detected in the upper atmosphere are presented. (auth)

10139 MUON CHARGE RATIO AT HIGH ENERGIES. Frohlich, Alfred (Tel-Aviv Univ., Israel); Leeman, Sidney. pp 2381-

6 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A simple phenomenological model is presented which predicts a slowly decreasing charge ratio with energy above 0.2 TeV, which is in accordance with recent measurements above 2.0 TeV and is not inconsistent with existing data at lower energies. Simultaneously it provides a good fit to the anisotropic muon flux at various zenith angles. Strangeness conservation in the primary collisions is explicitly incorporated and this suggests a constant kaonic charge excess at production, not a constant kaon charge ratio as has been previously assumed. (auth)

10140 ENERGY SPECTRA AND ANGULAR DISTRIBUTIONS OF HIGH-ENERGY MUONS. Amineva, T. P.; Cherdyntseva, K. V.; Christiansen, G. B.; (and others) (Moscow State Univ.). pp 2387-96 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A study of the energy spectra and angular distributions of the high energy cosmic-ray muons is presented. An installation detects the bremsstrahlung photons produced by muons in lead with two-side x-ray film in which the electron–photon cascades (EPC) produce dark spots. To determine EPC energy and the angle of EPC passage through the film, optical density of a spot and relative shift of spots in two emulsion layers were measured at several depths of the cascade development. About 20% of the films exposed have been processed by now. The first results are presented. (auth)

10141 ENERGY AND ANGULAR DISTRIBUTIONS OF MUONS IN THE TeV RANGE ACCORDING TO THE DATA OF EMULSION CHAMBER WITH X-RAY FILMS. Baradzei, L. T.; Kanevskaya, E. A.; Smorodin, Yu. A.; Soloviov, M. V. (Lebedev Inst. of Physics, Moscow). pp 2397-2407 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The paper represents further investigations of bremsstrahlung of muons by using emulsion chamber with x-ray films. The data of two yearly series of exposure are presented. The total exposure consisted of 32 tn. year. Two methods of determination of energy spectrum of muons were investigated. The first is similar to the method of ionization bursts, and the second to the calorimetrical method. The method developed of photometric determination of electron–photon cascade energy takes into account successively the dependence of density spot on incident angle and makes negligible the diffusion of light in photometric measurements. Both angular and energy distributions are consistent with the production of muons through $\pi-\mu$ decay. They do not give an indication of the existence of direct production of muons in the energy range 2 to 5 TeV. (auth)

10142 INTERPRETATION OF THE COSMIC-RAY ANISOTROPY. Allan, H. R. (Imperial Coll. of Science and Tech., London). Astrophys. Lett.; 12: No. 4, 237-41(Dec 1972).

The model of "compound diffusion" put forward by Lingenfelter et al. to describe the motion of cosmic rays in the Galaxy is criticized on the grounds that their calculated anisotropy refers to the flux across an area large compared with the scale size of magnetic irregularities, whereas the measured values refer to a single tube of force. (auth)

10143 ANOMALOUS RECURRENT DIURNAL ANISOTROPY IN COSMIC-RAY INTENSITY WITH MAXIMUM ALONG THE GARDEN-HOSE DIRECTION. Razdan, H.; Bemalkhedkar, M. M. (Physical Research Lab., Ahmedabad, India). Cosmic Electrodyn.; 3: No. 3, 297-315(Oct 1972).

During the recovery of a number of cosmic-ray intensity decreases of Forbush or gradual commencement type, cosmic-ray diurnal variation exhibits large amplitudes for 2 to 4 days with maximum along the garden-hose direction in the interplanetary space. These cosmic-ray intensity decreases are found to be associated with 27-day recurrent solar M region streams and in certain instances with a solar flare on the east limb as well. The anomalous diurnal variation also shows 27-day recurrence along with the associated world-wide cosmic-ray intensity decreases. The results are explained in terms of the important role played by the enhanced outward convection of cosmic-ray particles and an inward diffusion along the garden-hose direction in the specialized geometry of a transient modulating M region stream or a plasma cloud from an east limb flare. 30 references. (auth)

Stars

Refer also to abstracts 10210, 10213, 10218, and 10238.

10144 PROBABILISTIC MODEL FOR TIME-DEPENDENT TRANSFER PROBLEMS IN SPHERICAL SHELL MEDIA. Leong, T. K.; Sen, K. K. (Univ. of Singapore). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 21-36(1972).

A probabilistic model for solving time-dependent transfer problems in inhomogeneous, isotropic scattering, spherical shell media is proposed. Four probability functions are defined and an integro-differential equation for scattering function is deduced. Expressions for the emergent intensities in terms of scattering, transmission, back scattering, and back transmission functions are derived. (auth)

10145 LOCATION AND SIZE OF THE HOT SPOT IN CATACLYSMIC VARIABLE STARS. Warner, Brian; Peters, W. L. (Cape Town Univ.). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 15-20(1972).

Single particle trajectories have been calculated for material leaving the inner Lagrangian point of close binary systems at thermal velocities. The dimensions and location of the stream as it reaches the ring around the primary were calculated for a range of mass ratios. Applications to VV Pup and U Gem are given. (auth)

10146 MWC 349, A NEW RADIO STAR. Braes, L. L. E.; Habing, H. J.; Schoenmaker, A. A. (Lieden Observatory). Nature (London); 240: No. 5378, 230(24 Nov 1972).

Examination of the Westerbork 1415 MHz observations of the Cygnus X-3 region has revealed the presence of a radio source with flux density 0.060 ± 0.007 fu at the position of the peculiar emission line star MWC 349. An angular size of 20 arc s could be placed as an upper limit and positional data strongly suggest that the radio emission is associated with MWC 349, a star that appears to be an object of exceptional interest. The available data appear to indicate a binary system comprising a hot and a cool component embedded in a circumstellar cloud of gas and dust. The system may belong to the heavily obscured Cyg OB2 association centered about 0.5° to the north, such membership implying a distance of 2.1 kpc and an absolute visual magnitude of about −10, placing MWC 349 among the intrinsically brightest stars known. (auth)

10147 UBV PHOTOMETRY OF THE METAL-RICH GLOBULAR CLUSTER NGC 6171. Dickens, R. J.; Rolland, A. (Royal Greenwich Observatory, Herstmonceaux, Eng.). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 37-62(1972).

Three-colour (UBV) photographic photometry of stars in the globular cluster NGC 6171 is reported. The photometry is calibrated with a previously published photoelectric sequence and consists essentially of a revision and extension of an earlier colour–magnitude (C–M) diagram by Sandage and Katem (Astrophys. J.; 139:1088 (1964)), together with new ultraviolet measurements. The general character of the C–M diagram is unchanged, confirming the strong population of horizontal branch stars on the red side of the instability region, the large spread in colour on the red giant branch, possibly caused by the presence of asymptotic branch stars, and a small value of $\Delta V = 2.07$ mag. However, the red horizontal branch is shifted redwards by about 0.15 mag from its position in the earlier C–M diagram, which did not take account of colour equation, and there is a clear separation of about 0.1 mag between the red end of the horizontal branch and the subgiant branch. Other nonuniformities in the stellar distribution along the horizontal branch are discussed, together with the extremely small dispersion in V magnitude found there. The photographic ultraviolet colours confirm the previously found small ultraviolet excess of the giant stars, with a final best value of $\delta(U-B) = 0.09 \pm 0.03$ mag at $(B-V)_0 = 1.04$. Some of the stars probably belonging to the asymptotic branch have smaller ultraviolet excesses than subgiant stars of the same colour. The red giant stars appear to be more concentrated toward the cluster center than the stars on the horizontal branch. (auth)

10148 CONTACT BINARIES: OPACITY AND ROTATION. Whelan, J. A. J. (Univ. of Arizona, Tucson). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 63-77(1972).

A difficulty of contact binary theory is that models at age zero with unequal components can only be constructed, using the Lucy theory (Astrophys. J.; 151: 1123 (1968), and 153: 877 (1968)), for a limited range of periods and colours. It is shown that the age zero problem cannot be solved by significant opacity changes or consideration of uniform rotation. Nonuniform rotation can have a substantial effect on the parameters of model contact systems but it also is probably not sufficient to solve the age zero problem. It is shown that the observational objections to the Lucy model put

forward by Mauder (1972) and Robinson (1972) may be overcome by considering, respectively, more recent theoretical models and the possibility that the secondary component is the hotter one. The status of the Biermann–Thomas models (Astr. Astrophys.; 16: 60 (1972)), which apparently solve the age zero problem, is discussed. (auth)

10149 ACCRETION FLOWS AND THEIR STABILITY. Balazs, N. L. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 79-87(1972).

It is shown that in spherically symmetrical accretion flows the appearance of a maximum accretion rate is connected with the breakdown of the uniqueness of the solutions of the steady hydrodynamical equations. This result is analyzed and the properties of the resulting branches are stated. To understand which branch is realized in nature, the stability of these flows under spherically symmetric perturbations is analyzed for different polytropic indices γ. (auth)

10150 SPECTROGRAMS OF α LYRA AND β CEN IN THE REGION OF 2000 TO 3800 A. Gurzadyan, G. A.; Oganesyan, Dzh. B. (Byurakan Astrophysical Observatory, Erevan). Space Sci. Rev.; 13: No. 4-6, 647-50(1972).

Nine spectrograms of α Lyra and six spectrograms of β Cen were obtained with the help of the Orion system, in the range of wavelengths 2000 to 3800 A and with a spectral resolution of about 5 A near 2600 A. The data were taken during the flight of the Salyut. The experimental apparatus is described, but complete results will be given later. Examples of the spectrograms are shown. On the right of the spectrograms of α Lyra, the two last members of the Balmer absorption lines of hydrogen (H 8 and H 9) and the Balmer jump near 3650 A are visible. Clearly visible at 2800 A is a broad absorption line—the doublet of ionized magnesium (1796 Mg II and 2803 Mg II). A relatively intense absorption line near 2500 A is also clearly seen as well as some faint lines to the short-wave side of the spectrum. (J.C.W.)

10151 OPTICAL AND INFRARED OBSERVATIONS OF YOUNG STELLAR OBJECTS: AN INFORMAL REVIEW. Strom, S. E. (Kitt Peak National Observatory, Tucson, AZ). Publ. Astron. Soc. Pac.; 84: No. 502, 745-56(Dec 1972).

Recent theoretical work on pre-main-sequence evolution of stars is briefly reviewed. The review is discussed in terms of observations of young stellar objects, the influence of circumstellar envelopes on the interpretation of H–R diagrams, physical characteristics of circumstellar envelopes, envelope velocities, envelope geometry, and young stellar groups with ages less than 10^8 years. (W.D.M.)

10152 LUMINOSITIES AND MOTIONS OF A0 TO A2 STARS. Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 84: No. 502, 757-65(Dec 1972).

The space motions of 182 A0 to A2 stars (Strömgren's "intermediate group") are derived from luminosities determined by intermediate-band photometry. The accurate luminosities (mean error of ±0.2m) confirm a previous conclusion that the young disk population stars near the Sun occur in only some half-dozen groups. Although the photometric method used is confined to the small temperature range of log T_e from about 3.95 to 4.0, which represents main-sequence objects hotter than the bulk of the Hyades stars and therefore should include only disk stars younger than about 5×10^8 years, a few blue stragglers of the older disk population are also included. (auth)

10153 MASS LOSS AND INFRARED EXCESSES IN HOT STARS. Kleinmann, S. (Massachusetts Inst. of Tech., Cambridge); Kuhi, L. V. Publ. Astron. Soc. Pac.; 84: No. 502, 766-7(Dec 1972).

An attempt is made to show a positive correlation between mass loss and 10 μ flux in eight hot stars plus T Tauri. (W.D.M.)

10154 INFRARED OBSERVATIONS OF SOUTHERN RV TAURI STARS. Gehrz, R. D.; Ney, E. P. (Univ. of Minnesota, Minneapolis). Publ. Astron. Soc. Pac.; 84: No. 502, 768-71 (Dec 1972).

Photometric measurements from 2.2 μ to 18 μ are reported for six southern RV Tauri stars. Four of the six have anomalous infrared excess radiation similar to that observed in other RV Tauri stars. The infrared spectra of IW Car, AR Pup, and SX Cen resemble that of oxygen-rich RV Tau. RU Cen is similar to AC Her. (auth)

10155 REMARKS ON THE WOLF–RAYET BINARY CV SERPENTIS. Cowley, Anne (Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Pac.; 84: No. 502, 772-4(Dec 1972).

Recent photometric observations by Tcherepaschuk have been published, making it possible to intercompare the spectroscopic and photometric behavior of this peculiar system. (auth)

10156 INFRARED SPECTRUM OF ALPHA HERCULIS FROM 4000 TO 4800 cm^{-1}. Johnson, H. L. (Univ. of Arizona, Tucson); Thompson, R. I.; Forbes, F. F.; Steinmetz, D. L. Publ. Astron. Soc. Pac.; 84: No. 502, 775-8(Dec 1972).

A rapid-scanning Michelson interferometer (Fourier-transform spectrometer) was used on the Steward Observatory 229-cm reflector to observe infrared spectra of a dozen stars at 0.5 cm^{-1} resolution. The portion of the α Her spectrum from 4000 to 4800 cm^{-1} is presented. A number of atomic and molecular absorption features were identified. Most prominent were the CO $\Delta V = 2$ bands of $^{12}C^{16}O$; a feature which may be identified with $^{13}C^{16}O$ is pointed out. (auth)

10157 INFRARED SPECTRUM OF ALPHA HERCULIS FROM 5700 TO 6700 cm^{-1}. Thompson, R. I. (Univ. of Arizona, Tucson); Johnson, H. L.; Forbes, F. F.; Steinmetz, D. L. Publ. Astron. Soc. Pac.; 84: No. 502, 779-83(Dec 1972).

Spectra cover the region from 5700 to 6700 cm^{-1}, and include the second overtone bands of CO. (W.D.M.)

10158 MINIMA FOR THE ECLIPSING BINARY RT PERSEI. Drilling, J. S.; Landolt, A. U. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 502, 810-12(Dec 1972).

New times of minima derived from UVB photoelectric observations of RT Per are presented. (auth)

10159 APPARENT DISCONTINUITY IN THE PROPERTIES OF GIANTS OF THE DISK POPULATION. Hartwick, F. D. A. (Univ. of Victoria, B. C.); Hesser, J. E. Publ. Astron. Soc. Pac.; 84: No. 502, 813-15(Dec 1972).

By comparing the color–magnitude diagram of the metal-rich globular cluster 47 Tuc with that of bright field giants with the same $\delta(U-B)$, it is concluded that there are at least two different groups of giants that have the same line blanketing in the uv. It is suggested that a parameter other than age or abundance of elements heavier than the CNO group may be responsible for the observed discontinuity. (auth)

10160 PECULIAR SOUTHERN EMISSION-LINE OBJECTS WITH STRONG [O III] λ4363. Sanduleak, N.; Stephenson, C. B. (Warner and Swasey Observatory, Cleveland). Publ. Astron. Soc. Pac.; 84: No. 502, 816-17(Dec 1972).

Five stellar-like peculiar emission-line objects, having exceptionally strong [O III] λ4363 emission, were detected in a recently conducted objective-prism survey of the southern Milky Way. This feature and other characteristics suggest that these may be similar in nature to IC 4997 and several other strong λ4363 objects suspected of being protoplanetary nebulae. (auth)

10161 RATIO OF TOTAL TO SELECTIVE ABSORPTION FOR CARBON STARS. Honeycutt, R. K. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 84: No. 502, 823-6(Dec 1972).

The ratio of total to selective absorption for two carbon stars was evaluated by numerical integration of photoelectric spectral scans over the B and V bandpasses of the UBV system. It was found that R = 3.8 for carbon stars with very little dependence of R on color excess. (auth)

10162 NATURE OF X PERSEI; EVIDENCE FROM THE 1957 OUTBURST. Wackerling, L. R. (Northwestern Univ., Evanston, IL). Publ. Astron. Soc. Pac.; 84: No. 502, 827-33 (Dec 1972).

In mid-1957 there occurred in the spectrum of the O star X Per, near the x-ray source 2U0352 + 30, abrupt changes in the emission-line radial velocities and V/R ratios. The irregular variation of the V/R ratio, also observed in the past by McLaughlin, suggests the occasional interruption of a more or less steady infall of material through the rotating emission region by outbursts of material from the star. The space velocity of X Per has been rederived, using a revised radial velocity, and compared to the space velocity of the runaway O star ξ Per. The calculated closest approach of the two stars, to 17 pc separation, occurred 2.4×10^6 years ago. (auth)

10163 SPECTROSCOPIC CHANGES IN THE SUSPECTED X-RAY SOURCE X PERSEI. Cowley, A. P.; McLaughlin, D. B.; Toney, J.; MacConnell, D. J. (Univ. of Michigan, Ann Arbor). Publ. Astron. Soc. Pac.; 84: No. 502, 834-8(Dec 1972).

Spectrograms from 1913 to the present show X Per to have bright H lines that are variable in structure, velocity, and intensity. At times the spectrum is veiled and very few features can be distinguished. During some phases emission of Fe II, Ti II, He I, and He II are seen. Very weak, broad absorption lines suggest the underlying star is near O9. No periodicities are suggested by the data, although periods shorter than a few months cannot be ruled out. The slowly changing velocity of the He I absorption lines is particularly difficult to interpret. (auth)

10164 METAL DEFICIENCY OF THE SECONDARY COMPONENT OF S VELORUM. Bond, H. E. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 502, 839-41(Dec 1972).

An ultraviolet spectrogram of the Algol-type binary S Vel was obtained during total eclipse. The spectrum shows no inconsistency with the hypothesis that the ultraviolet excess of the secondary star is due to a moderate metal deficiency. (auth)

10165 ADDITIONAL OBSERVATIONS OF SOME STARS WITH STRONG HELIUM LINES. Lee, P.; Daigle, P. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 84: No. 502, 842-3(Dec 1972).

Several photoelectric observations of a new addition to the list of hydrogen-deficient stars, HD 184927, and of some of the stars in Landolt's (1968) list were obtained in the UBV and UBVr systems. (W.D.M.)

10166 1971 PALOMAR SUPERNOVA SEARCH. Kowal, C. T.; Sargent, W. L. W.; Searle, L.; Zwicky, F. (Carnegie Institution of Washington, DC). Publ. Astron. Soc. Pac.; 84: No. 502, 844-9(Dec 1972).

Nine supernovae were discovered with the 48-inch Schmidt telescope at Palomar during 1971. In addition eleven were found on old plates of the Palomar Sky Survey. (W.D.M.)

10167 NEW SYMBIOTIC-LIKE OBJECT BEHIND THE COALSACK. Weaver, W. B. (Warner and Swasey Observatory, Cleveland). Publ. Astron. Soc. Pac.; 84: No. 502, 854-5(Dec 1972).

A new object with a combination spectrum was discovered. It probably lies about 2.3 kpc behind the Coalsack. (auth)

10168 QUANTUM MECHANICAL TREATMENT OF LONGITUDINAL PLASMA WAVES IN STELLAR PLASMAS. Littleton, J. E. Rochester, NY; Univ. of Rochester (1972). 111p. University Microfilms Order No. 72-28,771.

Thesis.

A Hamiltonian is derived for the longitudinal oscillations of a two-component, fully ionized, continuum plasma in thermal equilibrium. This Hamiltonian is then quantized and diagonalized so that the quantized plasma waves may be treated as quasi-particles. The interaction of the quasi-particles with the material particles of the plasma is applied to a first-order, time-dependent perturbation calculation of the emission and absorption of plasma waves within the plasma. A thermal equilibrium distribution of the plasma waves is obtained in the approximation that the perturbations have a negligible effect on the equilibrium particle distributions. The quasi-particle distributions are independent of the degree of nonrelativistic degeneracy of the plasma. The damping of the quasi-particles by the material particles is calculated and shown to be equivalent to Landau damping for the plasmons, or electron plasma oscillations, and the usual damping for the phonons, or ion-acoustic oscillations. The lowest order wave–wave interactions are calculated and the linearized transition rates for them are shown to have no effect on the equilibrium distributions. The plasmon damping which results from the emission and absorption of phonons by plasmons is computed and removes the essential singularity of the wave–particle plasmon damping at very long wavelengths. The correlation of charge-density fluctuations is obtained and shown to be equivalent to the correlations obtained from the fluctuation–dissipation theorem. The results are applied to a calculation of the longitudinal wave contributions to the thermal conductivity and viscosity in stellar plasmas. Additional applications of this formalism are also discussed. (Diss. Abstr. Int., B)

10169 SPECTRUM VARIATIONS IN A-TYPE SUPERGIANTS. II. A SEARCH FOR EVIDENCE FOR COUPLING BETWEEN MASS LOSS AND TURBULENCE IN ALPHA CYGNI. Rosendhal, J. D. (Univ. of Arizona, Tucson). Astrophys. J.; 178: No. 3, 707-14 (15 Dec 1972).

An extensive time sequence of Hα spectrograms of α Cygni was analyzed for changes in line strengths and radial velocities in order to look for evidence for coupling between macroturbulence, microturbulence, and mass loss. The results of the analysis revealed the existence of the same type of coupling between large- and small-scale mass motions that has been previously found, but they did not reveal any connection between these motions and the changes in the flows responsible for the mass loss. In particular no correlation was found between changes in the microturbulence and changes in the gradient of the flow velocity. Additional constraints on the behavior of the mass flow suggested by the observations are also discussed. (auth)

10170 INFRARED RADIATION FROM RV TAURI STARS. I. AN INFRARED SURVEY OF RV TAURI STARS AND RELATED OBJECTS. Gehrz, R. D. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 178: No. 3, 715-25(15 Dec 1972).

Broad-band photometric measurements from 2.2 to 22 μ were made for 25 RV Tauri stars and 50 comparison objects. All 11 RV Tauri stars for which the [3.6] – [11.3] color was measured showed anomalous excess 11.3-μ radiation. Six of 8 RV Tauri stars for which upper limits to the [3.6] – [11.3] color were set may have large infrared excesses. Most RV Tauri stars are embedded in extended cool dust envelopes. Metallic silicates are present in the dust surrounding oxygen-rich RV Tauri stars while an unidentified substance has condensed around the carbon-rich RV Tauri star AC Her. Dust production in RV Tauri stars becomes enhanced as metal abundance increases. (auth)

10171 ULTRAVIOLET PHOTOMETRY FROM THE ORBITING ASTRONOMICAL OBSERVATORY. IV. PHOTOMETRY OF LATE-TYPE STARS. Doherty, L. R. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 3, 727-42(15 Dec 1972).

Broad-band interference-filter photometry obtained with OAO-2 at four ultraviolet wavelengths is presented for 57 normal, bright stars of spectral type A2 to M. Relative digital counting rates are given for selected filter-photometer combinations with effective wavelengths of 3320, 2980, 2460, and 1910 Å. Errors in the net stellar counts depend principally on variations in instrument sensitivity and dark counts due to effects of the Earth's radiation belt. For the cooler stars, uncertainties in sky background can be significant. Corrections for identified secondary stars in the wide (10 arc minute) field are estimated for one-third of the pointings. Internal consistency and low dispersion in color–color diagrams indicate that errors of ±2% at the longer wavelengths and ±10% at shorter wavelengths are typical. Color–color diagrams show that there is remarkably little intrinsic variation in ultraviolet properties among stars with the same visual color and luminosity class, if class I supergiants are excepted. The correlation between 2460 – V and 2980 – 3320 is particularly good and, moreover, independent of luminosity, again with the exception of class I stars. Generally, A and F supergiants are fainter than main-sequence stars of the same type by about two magnitudes at 2460 Å and 1910 Å, relative to the visual. K and M supergiants are brighter than giants by about the same amount. OAO and ground observations of ι UMa (A7 V), 24 UMa (G4 IV), and α Ari (K2 III) from 1910 Å to 1 μ are compared with blanketed models from the Smithsonian grid. Good agreement is possible for all wavelengths considered except 2460 Å, which is weaker than predicted. This discrepancy increases from 0.5 mag at A7 to about 2 mag for α Ari. (auth)

10172 SPECTROSCOPIC STUDY OF THE STRONG HELIUM-LINE STAR HD 37017. Lester, J. B. (Yerkes Observatory, Williams Bay, WI). Astrophys. J.; 178: No. 3, 743-61(15 Dec 1972).

The peculiar early-type star HD 37017 was studied using model stellar-atmosphere techniques in an attempt to determine the reason for the enhanced strength of its helium absorption lines. It was found that the helium abundance is approximately twice as great as that found for the nearby control star HD 37016. The mass and radius of HD 37017 were found to be inconsistent with its effective temperature when it was compared to the control star. The possibility of binary mass transfer is discussed. (auth)

10173 MOLECULAR HELIUM BANDS IN GRW + 70°8247. Wickramasinghe, D. T.; Thompson, R. I.; Strittmatter, P. A. (Univ. of Arizona, Tucson). Astrophys. J.; 178: No. 3, 763-9 (15 Dec 1972).

The possibility that molecular helium bands are present in the spectrum of Grw + 70°8247 is discussed in terms of model atmospheres. Given the various observational constraints it is difficult to produce the required amount of He_2 in the photosphere of Grw + 70°8247. In particular, the metal and hydrogen abundances should be extremely low ($N_M/N_{He} \ll 10^{-5}$, $N_H/N_{He} \ll 10^{-6}$), and the effective temperature should be less than the 12,000°K indicated by the spectrophotometric scans. Problems associated with pressure broadening at the required densities (10^{22} to 10^{23} cm^{-3}) are also discussed. (auth)

10174 ADVANCED EVOLUTION OF MASSIVE STARS. IV. SECONDARY NUCLEOSYNTHESIS DURING HELIUM BURNING. Couch, R. G.; Arnett, W. D. (Univ. of Texas, Austin). Astrophys. J.; 178: No. 3, 771-7(15 Dec 1972).

The thermonuclear processing of ^{14}N during core helium burning in massive stars is examined. A detailed discussion of the relevant reaction rates is given, including the evaluation of recent experimental data, and the presentation of analytic fits for $N_A\langle\sigma v\rangle$. If, as seems likely, the ^{12}C and ^{16}O observed was produced under such conditions, then most, if not all, the ^{22}Ne was produced at the same time by the sequence $^{14}N(\alpha,\gamma)^{18}F(\beta^+)^{18}O(\alpha,\gamma)^{22}Ne$. For stars in the mass range ($4 \lesssim M/M_\odot \lesssim 8$) it is unlikely that ^{25}Mg, which can be an effective contributor to the Urca process, is greatly enhanced by helium burning. (auth)

10175 RADIATIVE TRANSFER IN SPHERICALLY SYMMETRIC FLOWS. Castor, J. I. (Univ. of Colorado, Boulder). Astrophys. J.; 178: No. 3, 779-92(15 Dec 1972).

The transfer of radiation in a spherically symmetric moving medium is considered, including those corrections which are of the order of the flow velocity divided by the velocity of light. The formulation uses the radiation quantities which would be seen by an observer moving with the fluid. The equation of transfer satisfied by the intensity I_ν, and the moment equations satisfied by the radiation moments J_ν, H_ν, and K_ν, or by J, H, and K, are obtained. The lowest frequency-integrated moment equation has the significance of being the first law of thermodynamics as applied to the radiation, and its use ensures that due account is taken of the internal energy and pressure of radiation in overall energy conservation. The fluid equations including the effects of matter-radiation coupling and the law of total energy conservation are discussed. In the latter, it is found that the term which represents the difference of the radiative flux between the fluid frame and the stationary frame can be considered as the convective flux of radiative enthalpy. Some possible approximations which might be applied to the various forms of the transfer equation in order to make them computationally tractable are considered. One of these is readily adaptable to present linear and nonlinear stellar pulsation calculations. (auth)

10176 HYDRODYNAMIC AND RADIATIVE-TRANSFER EFFECTS ON AN RR LYRAE ATMOSPHERE. Hill, S. J. (Joint Inst. for Lab. Astrophysics, Boulder, CO). Astrophys. J.; 178: No. 3, 793-808(15 Dec 1972).

A nonlinear hydrodynamic model atmosphere was produced to understand the phenomenon of shock-wave development in Bailey type-a RR Lyrae stars. Results of this model were used in a fine-structure steady-state model for the shock waves. These two models supplied the information for a successful comparison of light curves, absorption-line velocities, and emission strengths with X Ari. Significant shock-wave dissipation is noted, while there is an understandable lack of mass loss. (auth)

10177 PROPER MOTION OF BD + 16°516. van Albada, G. D. (Leiden Observatory). Astron. Astrophys.; 22: No. 1, 157(Jan 1973).

A new proper motion is given for the Hyades white dwarf eclipsing binary BD + 16°516. (auth)

10178 INFRARED PHOTOMETRY OF SOUTHERN WOLF–RAYET STARS. Allen, D. A. (Carnegie Inst. of Washington, DC); Porter, F. C. Astron. Astrophys.; 22: No. 1, 159-60(Jan 1973).

With the exception of a few WC stars, the nitrogen and carbon sequences of the southern Wolf–Rayet stars can be distinguished by photometry at 1.6 and 2.2 μ. (auth)

10179 HELIUM RED GIANTS. Trimble, V. (Univ. of California, Irvine); Paczynski, B. Astron. Astrophys.; 22: No. 1, 9-12(Jan 1973).

Models of helium red giants have been obtained for stars in the mass range 0.7 to 10 $M_\odot$. The models have degenerate carbon–oxygen cores, helium burning shell sources, and helium envelopes. Their absolute bolometric magnitudes are −3 to −7, and their effective temperatures range from $\log T_e = 3.0$ to 3.8. The higher the total mass and metal abundance of a model, the lower is its effective temperature. The higher the assumed rate of neutrino emission, the easier it is to obtain a helium red giant in the course of evolutionary computations. The relation of the models to observed helium-rich red giants (R Corona Borealis variables) is discussed. (auth)

10180 OPTICAL OBSERVATIONS OF THREE NEW INFRARED SOURCES. Allen, D. A. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 12: No. 4, 231-4(Dec 1972).

Low-dispersion slit spectra and direct photographs were secured of the objects associated with the recently discovered infrared sources in NGC 2264 and M1–82. The former is interpreted as a heavily reddened star. The sources in M1–82 are probably young Be stars with circumstellar envelopes. (auth)

10181 ABUNDANCE ANOMALIES IN THE ON TYPE STAR HD 188209. Baschek, B.; Kodaira, K.; Scholz, M. (Univ., Heidelberg). Astrophys. Lett.; 12: No. 4, 227-9(Dec 1972).

Comparison of the line spectrum of the ON type star HD 188209 with ζ Ori A shows that its atmosphere has a peculiar chemical composition. The anomalous abundances can be explained by an admixture of about 20 to 40% of matter processed by the CNO cycle. (auth)

10182 EVOLUTION FROM THE MAIN SEQUENCE TO THE HELIUM FLASH FOR POPULATION II STARS. Demarque, P.; Mengel, J. G. (Yale Univ., New Haven). Astron. Astrophys.; 22: No. 1, 121-8(Jan 1973).

Evolutionary turnoffs from the main sequence for stars of low mass with the composition parameters $0.50 \geq Y \geq 0$ and $Z = 10^{-3}$ and 10^{-4} are presented and compared with previous results. The evolution of red giants to the helium flash is also investigated in an attempt to determine more reliably: (a) the effect of chemical composition on the position and slope of the giant branch; (b) the dependence on the original value of Y of the core mass and maximum luminosity at the helium flash; (c) the dependence of red-giant lifetimes on the total mass of the star. The position and extent of the luminosity dip discovered by Thomas (1967) is also briefly discussed. (auth)

10183 SPECTROSCOPIC SURVEY OF SOUTHERN HEMISPHERE WHITE DWARFS. I. THE NATURE OF CD −42° 14462. Wegner, Gary (Australian National Univ., Canberra). Astrophys. Lett.; 12: No. 4, 219-25(Dec 1972).

New observations of the peculiar star CD −42° 14462 are presented. The spectrum is composite. The possibilities that the star is a main-sequence star, and old nova, a close short-period binary of two white dwarfs, or a rapidly-rotating white dwarf are explored. (auth)

10184 PLANE-SYMMETRIC POLYTROPIC FUNCTIONS. Tascione, T. F. (Univ. of Massachusetts, Amherst). Astrophys. J., Suppl. Ser.; 24: No. 212, 479-91(Oct 1972).

The plane-symmetric polytropic functions are tabulated to five figures for 11 values of the polytropic index in the range $0.5 \leq n \leq 25$. The incomplete beta function, $B_x(a,b)$ is also tabulated for $0 \leq x \leq 1$, $a = \frac{1}{2}$, $2/3 \geq b \geq 1/26$. (auth)

10185 COMPUTER SOLUTION OF ECLIPSING-BINARY LIGHT CURVES BY THE METHOD OF DIFFERENTIAL CORRECTIONS. Proctor, D. D.; Linnell, A. P. (Michigan State Univ., East Lansing). Astrophys. J., Suppl. Ser.; 24: No. 211, 449-77(Oct 1972).

A group of computer programs rectifies individual observations defining an eclipsing-binary light curve according to the Russell model and produces a final set of parameters by differential corrections. The present program applies to systems which can be represented to first order in their oblateness. A sample solution of MR Cygni permits a comparison with other published solutions and demonstrates the ability of the present programs to fit a light curve to within the accuracy of its observational definition. (auth)

10186 HYDROMAGNETIC OSCILLATIONS AND STABILITY OF SELF-GRAVITATING MASSES. III. MAGNETIC POLYTROPES. Grover, S. D. (Atma Ram Sanatan Dharma Coll., New Delhi); Singh, Surindar; Tandon, J. N. Astron. Astrophys.; 22: No. 1, 133-7(Jan 1973).

A variational principle is developed to study the oscillations and stability of magnetic polytropes. It is then applied to study the special case of the n = 1 polytrope using five parameter trial functions. In addition to the nontrivial Kelvin mode, two pulsational modes and two convectively unstable modes were obtained. The effect of magnetic field on these modes is discussed in detail for l = 1, 2, and 3. (auth)

10187 STABILITY CRITERIA FOR TRIPLE STARS. Harrington, R. S. (Naval Observatory, Washington, DC). Celestial Mech.; 6: No. 3, 322-7(Nov 1972).

A wide variety of equal-mass stellar triple systems was numerically integrated in order to establish factors pertinent to stability. The significant parameters appear to be whether the relative revolution is direct or retrograde, and the ratio of the periastron distance in the outer orbit to the semi-major axis of the inner orbit. For stability, this ratio must be at least 3.5 for direct orbits and at least 2.75 for retrograde orbits. (auth)

10188 uv INTERSTELLAR ABSORPTION LINES IN THE SPECTRUM OF ζ PUP. de Boer, K. S.; Hoekstra, R.; van der Hucht, K. A.; (and others) (Astronomical Inst., Utrecht). Astron. Astrophys.; 21: No. 3, 447-8(Dec 1972).

Interstellar absorption lines were detected in the spectrum of the O5 star ζ Pup. They are due to the resonance lines of Mg II λ2803, 2796, Mg I λ2852, Fe II λ2586, and Mn II λ2576, and possibly Fe I λ2522. (auth)

10189 DISINTEGRATION OF STAR CLUSTERS. Bouvier, P. (Geneva Observatory). Astron. Astrophys.; 21: No. 3, 441-2(Dec 1972).

By fitting a simple analytical model to some former numerically computed results for a 25-solar mass stellar cluster, a value is obtained for the disruption time of the cluster submitted

to three disintegration causes: its inner evolution, the galactic tidal field, and the influence of passing interstellar clouds. (auth)

10190 ANALYSIS OF THE SPECTRUM OF THE METALLIC-LINE STAR 63 TAURI. Hundt, E. (Univ., Heidelberg). Astron. Astrophys.; 21: No. 3, 413-30(Dec 1972).

A fine analysis of 63 Tau based on high dispersion spectra was carried out. The derived model atmosphere parameters are: effective temperature T_{eff} = 7750° ± 200°, surface gravity log g = 4.3 ± 0.3, microturbulent velocity ξ = 5.0 ± 0.5 km/s (depth independent). The atmospheric structure does not deviate from that of a normal main-sequence star, except for a lower surface temperature caused by stronger line blanketing which is derived empirically. The influence of the secondary component of the binary system on the analysis was investigated, and found to be negligible. The element abundances found in earlier analyses (deficiency of Ca and Sc, overabundance of all heavier elements) were essentially confirmed. A linear correlation was found between the overabundances in 63 Tau and the normal abundances. From the view of this correlation, not only Ca and Sc, but also Zr and probably K are underabundant. The results are discussed with respect to element diffusion after Michaud (1970), a proposed process for the metallic-line phenomenon. This hypothesis would predict a deficiency of Y rather than of Zr. (auth)

10191 DESTRUCTION OF THE s PROCESS (nσ) CORRELATIONS BY ELECTRON CAPTURE AFTER NEUTRON IRRADIATION. Arnould, M. (Univ. Libre, Brussels). Astron. Astrophys.; 21: No. 3, 401-12(Dec 1972).

This paper studies the extent to which the isotopic or elemental (nσ) correlations for s-only nuclei can be affected by electron capture after neutron irradiation in media at various (even low) temperatures and densities. It is shown that the isotopic Te correlation can be destroyed to a relatively great extent in most part of the C–O and Ne–O regions of a great variety of stars which have evolved beyond central helium burning. This is also the case, but to a lesser extent, for the Sr and Os isotopic correlations. If the destruction of those various (nσ) correlations must be weak enough to be compatible with the possible range of values of the experimentally determined solar system (nσ) products, rather drastic limitations can be derived either for the time possibly spent by the s nuclides in the neutron depleted parts of the C–O and Ne–O regions of many stars if it is assumed that a relatively important part of the solar system s elements come directly from such sites, or for the maximum fraction of the solar system s elements which may come directly from those layers if the s nuclei can spend there such a long time that the (nσ) correlations can possibly be largely destroyed. It must be noticed that the limitations of that kind gained from Os are rather uncertain, because the cosmoradiogenic contribution from ^{187}Re is difficult to estimate satisfactorily. (auth)

10192 MODEL FOR THE HELIUM SPECTRUM VARIABLE α CENTAURI. Norris, J. (Univ. Heidelberg); Baschek, B. Astron. Astrophys.; 21: No. 3, 385-92(Dec 1972).

An empirical model is proposed to explain the observed variations of the helium spectrum variable α Centauri. The model consists of a rotating star, the surface of which consists of a small helium rich region (spot), and a large helium deficient region (non-spot). The non-spot resembles a weak-helium-line star with T_e = 21000°, log g = 4.2 and y = N(He)/[N(He) + N(H)] = 0.004. Assuming that gravity remains constant over the surface, the observations of continuum, helium and hydrogen line strengths are used to determine the parameters of the two region model: the area of the spot, A = 0.3 in units of hemispheres, the difference in helium abundance Δy = y(spot) – y(non-spot) = 0.8; and the difference in effective temperature ΔT_e = –1600°. The variations of metallic lines and radial velocities can then be explained with this model. In particular, one can simply obtain the observed constancy of Si II lines and the variability of the Si III lines. Because of differences in scale heights between the helium rich and the helium poor regions it is suggested that a magnetic field (~500 Gauss) may provide the restraining force necessary to maintain the identity of the two regions. It is speculated that the formation of the α Centauri phenomenon requires a two stage process involving a transfer of helium-rich material from an evolving companion, together with the process (whatever it may be) at work in the weak-helium-line stars. (auth)

10193 SPECTROSCOPIC STUDY OF THE PECULIAR STARS IN THE OPEN CLUSTER NGC 2516. Dachs, J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 21: No. 3, 373-83(Dec 1972).

Coudé spectrograms with a dispersion of 20 Å/mm were taken for 22 stars in the open cluster NGC 2516 which is known to contain three red giants and several stars with peculiar spectra. The red giants are confirmed to be members of the cluster from measurement of their radial velocities and examination of their proper motions. Three new peculiar B- and A-type stars of the Si and the Ti–Si groups as well as a second B-emission lines star were detected in the cluster. Thus, a total of nine stars in the cluster show strong peculiarities in their spectra among 39 early-type stars for which coudé spectra have so far obtained Six of them belong to the Si or Ti–Si groups. The most interesting spectrum is that of the A0p (Ti–Si) star HD 66318 which shows the Si II λλ4128/4131 Å doublet lines with equivalent widths exceeding 0.8 Å. In the spectra of six stars, the Hg II λ 3984 Å line is distinctly present. Equivalent widths are given for a small number of strong lines for all peculiar stars in the cluster. The peculiar stars in NGC 2516 are located on the main sequence with absolute visual magnitudes between $-1.8m < M_V < +1.5m$. Arguments are presented suggesting that the silicon stars in NGC 2516 were formed by accretion onto their surfaces of silicon-rich matter lost from red giant stars which once were their companions in widely separated binary systems. This interpretation of the silicon stars leads to the conclusion that stars with masses of about 5 to 9 solar masses, after the red-giant stage, usually do not end their evolution by supernova explosions, but by becoming white dwarfs after relatively slow mass loss. (auth)

10194 SPLITTING OF LINES IN DIFFERENTIALLY ROTATING SLABS. Magnan, C. (Observatoire, Meudon, France). Astron. Astrophys.; 21: No. 3, 361-71(Dec 1972).

Line profiles for rotating disks with continuous absorption are constructed. The source function is calculated by means of Monte-Carlo techniques. The effects of various parameters such as the dimension of the slab and the velocity are investigated. The splitting of the line into two or more components is a natural consequence of the rotation. (auth)

10195 EFFECTS OF VELOCITY AND TURBULENCE GRADIENTS ON A-TYPE SUPERGIANT SPECTRA. Groth, H. G. (Univ., Munich). Astron. Astrophys.; 21: No. 3, 337-53(Dec 1972).

The observed variations of radial velocities of some supergiants are compiled. Measurements of differential line displacements in spectra of α Cyg and φ Cas are presented. These observations can be interpreted, if one assumes a depth dependent radial velocity, which is varying with time. The microturbulence is also depending on optical depth. A series of models for an A2-type supergiant have been computed, assuming different velocity fields and microturbulence fields. Using these models the equivalent widths and the differential displacements of lines of some ions of several elements were calculated. (W.D.M.)

10196 DYNAMICAL EVOLUTION OF TRIPLE STAR SYSTEMS: A NUMERICAL STUDY. Standish, E. M. Jr. (Yale Univ., New Haven). Astron. Astrophys.; 21: No. 2, 185-91(Nov 1972).

The initial conditions for 800 triple star systems were created and the evolution was followed, usually until the escape of one member. It was found that the angular momentum of the system was the quantity most influential in determining the following distributions: the time of disintegration, the velocity and mass of the escaping particle, the semi-major axis, eccentricity and angular momentum of the remaining binary. These quantities are displayed graphically and discussed. (auth)

10197 MONOCHROMATIC OBSERVATIONS OF SOME PLANETARY NEBULAE. Hua, C. T. (Laboratoire d'Astronomie Spatiale, Marseille); Louise, R. Astron. Astrophys.; 21: No. 2, 193-8(Nov 1972). (In French).

Monochromatic images were obtained by using the "Réducteur Focal" apparatus (Courtès, 1960) combined with the narrow passband interference filters (Δλ = 10 Å) respectively centered on Hα(λ = 6563 Å), [N II] (λ = 6584 Å), and [O III] (λ = 5007 Å). The observations were made with the 120 cm and 80 cm telescopes of the Haute Provence Observatory. Several plates were taken on eight planetary nebulae with different exposure times. The results show that the [N II] image is generally greater than (or at least equal to) the Hα one. This confirms the results obtained on the other nebulae (Carranza et al., 1968; Hua et Louise, 1970). Furthermore, the [N II] line is not observed in two nebulae (NGC 1514 and NGC 7008). This is probably connected with the deficiency of nitrogen. (auth)

10198 SPECTRUM OF o^2 C Ma, B3 Ia. II. INTERPRETATION OF THE OBSERVATIONS. van Helden, R. (Astronomical Inst., Utrecht). Astron. Astrophys.; 21: No. 2, 209-22(Nov 1972).

An LTE fine analysis is presented based on a study of eleven high-dispersion spectrograms of o^2 C Ma B 3 Ia. The line profiles are well explained by the LTE approach. The chemical composition of o^2C Ma (B3 Ia) is close to the composition of l Her (B3 V)

but oxygen is deficient by a factor of about four. The Hα line profile changes on a time scale of 30 min or less. The radial velocity of o^2C Ma is +49.1 ± 0.5 km s^{-1}. The behavior of the radial velocities and equivalent widths of the C II lines is rather puzzling. The radial velocity of the Balmer lines suggests an outstreaming atmosphere. The mass loss is of the order of 10^{-8} $M_\odot$ $year^{-1}$. The star is situated at a distance of 912 ± 42 pc, which is 282 ± 151 pc behind the galactic cluster Cr 121, but it may have originated in the cluster. The age of o^2C Ma is estimated to be $(7.5 \pm {}^{4.0}_{2.5}) \times 10^6$ years. (auth)

10199 STATE OF IONIZATION IN NOVA SHELLS. I. THE IONIZATION EQUATION FOR HYDROGEN SHELLS. Bosma, P. B. (Kapteyn Astronomical Inst., Groningen, Netherlands). Astron. Astrophys.; 21: No. 2, 223-9(Nov 1972).

The ionization equation for a spherically symmetric hydrogen shell illuminated by a central star is derived. An approximate solution of this equation quantitatively shows that for optically thick shells nearly all photons arising from recombinations are reabsorbed, whereas for optically thin shells nearly all these photons escape. This justifies assumptions made by Grotrian and Sobolev in earlier work. For shells of intermediate optical thickness the fraction of photons arising from recombinations escaping from the shell can be calculated relatively easily with the help of the correction functions introduced in this paper. The degree of ionization can be determined as a function of the optical depth with a high degree of accuracy. (auth)

10200 DETERMINATION OF THE MEAN ABSOLUTE MAGNITUDE OF RR LYRAE STARS. Heck, A. (Institut d'Astrophysique, Liege). Astron. Astrophys.; 21: No. 2, 231-8(Nov 1972). (In French).

The method used is that based on the principle of maximum likelihood developed by Jung (1970) with some improvements. The bias and the precision of the estimates were calculated by numerical experiments. The method was applied to a sample of 102 RR Lyrae stars, after elimination of high velocity stars and of stars with large errors on the proper motions, in order to determine mean absolute photographic magnitude and the corresponding dispersion. It was found that $\overline{M}_{pg} = 0.6 \pm 0.2$ and and $\sigma_{Mpg} = 0.5 \pm 0.2$, the bias being taken into account. The study of the correlations between $\overline{M}$, the period P, the abundance parameter ΔS and the amplitude of the light variation A, showed that on ground of the present data, no significant correlation can be established. However, the results have hinted at a correlation between $\overline{M}$ and P, and also between $\overline{M}$ and A. (auth)

10201 LONG WAVELENGTH SPECTROMETRY AND PHOTOMETRY OF M, S, AND C-STARS. Hackwell, J. A. (Univ. of Wyoming, Laramie). Astron. Astrophys.; 21: No. 2, 239-48(Nov 1972).

Spectral measurements of 11 stars corrected for atmospheric absorption from 8 to 13 μ with a resolution, $\Delta\lambda/\lambda = 0.013$ and independent photometric measurements in 7 bands between 2 μ and 20 μ of 45 selected M, S, and C-stars are presented. The infrared excesses of the stars near 11 μ are generally seen to be smooth with wavelength, although there is evidence of a molecular absorption band in the spectrum of RX Boo. Where the photometry and spectrometry overlap, the spectral shapes obtained from each of them are in general agreement. (auth)

10202 EVIDENCE FOR A SUSPECTED PERIOD CHANGE OF SX PHOENICIS. Stock, J. (Univ. of Chile, Santiago); Kunkel, W. E.; Hesser, J. E.; Lasker, B. M. Astron. Astrophys.; 21: No. 2, 249-53(Nov 1972).

New photoelectric observations in the UBV- and H_β-systems of the short-period variable star SX Phoenicis (HC 223065) are presented. When combined with earlier data, the UBV observations indicate the existence of a small variation of the basic periods. (auth)

10203 DYNAMICAL EVOLUTION OF A STELLAR CLUSTER WITH INITIAL SUBCLUSTERING. Aarseth, S. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.); Hills, J. G. Astron. Astrophys.; 21: No. 2, 255-63(Nov 1972).

Considerations based on star-formation theory suggest that stellar clusters should initially be composed of a hierarchy of subclusters. The integrated gravitational self-binding energy of these subclusters is quite substantial, and consequently their breakup is potentially a major factor in the evolution of the cluster. To test their influence the evolution of a 120-star cluster having initially such a hierarchy of subclusters was computer simulated. The subclusters broke up in one dynamical collapse time, τ_{ff}. However, the effect of transferring their self-binding energy to the cluster as a whole was nearly exactly balanced by the formation of tightly-bound binary stars which acquired increasing amounts of binding energy at the expense of the cluster. The net result was that the final radius of the cluster was nearly the same as it would be if there was no initial subclustering and no binary-star formation. However, the initial subclustering did have some irreversible consequences. The dynamical relaxation of the cluster was more violent than in a cluster without subclustering; by time 2 τ_{ff} more than one third of its stars had been, and often very violently, ejected from the cluster. Related to this high rate of energetic ejections was the fact that binary-star formation during this time was far more vigorous than in a cluster without initial subclustering. (auth)

10204 STELLAR KINEMATICS IN THE SCO OB1 ASSOCIATION. Laval, A. (Observatory, Marseille). Astron. Astrophys.; 21: No. 2, 271-8(Nov 1972). (In French).

From an earlier paper (H II regions in the Sco OB1 association) one could deduce that the gas belonging to this association is clumping into two subgroups. This paper deals with the stellar study where it is shown that the same subgroups appear among the stars: two stellar groups can be distinguished which behave differently in kinematics. These subgroups coincide with the gaseous subgroups. The stars of the southern group are concerned with an expansion which affects both proper motions and radial velocities. The effect is more significant than what will be expected from the mean error alone. Lack of data allowed no conclusion about expansion within the northern group. The agreement is good for the radial velocities obtained from stars and from H II regions within each group; this shows that the different components of the association (stars and gas) originated from the same initial cloud. (auth)

10205 UNIFORMLY ROTATING STARS WITH HYDROGEN- AND METALLIC-LINE BLANKETED MODEL ATMOSPHERES. Maeder, A. (Observatoire, Geneva); Peytremann, E. Astron. Astrophys.; 21: No. 2, 279-84(Nov 1972).

The energy distribution of uniformly rotating stars including continuous, hydrogen and metallic line opacities are computed for a 1.4 $M_\odot$ star. Colors and parameters are computed in the UBV, uvby, and Geneva Observatory photometric systems. The effects of rotation predicted by these models are 10 to 25% larger than those of models of Maeder and Peytremann (1970) with continuous and H-line opacities. However, there is still a large discrepancy between uniformly rotating models and observations of stars with spectral type later than A7V: the rotational effects given by the models are smaller, at least by a factor 2, than the observed effects. Except for uniform rotation, the other assumptions have received some justification. Furthermore, the synthetic spectra have now been computed with more realistic opacities. So one may conclude that stars of spectral type later than A7V do not rotate uniformly. (auth)

10206 HYDRODYNAMIC MODEL CALCULATIONS FOR SUPERMASSIVE STARS. II. COLLAPSE AND EXPLOSION OF A NONROTATING 5.2×10^5 $M_\odot$ STAR. Appenzeller, I. (Tokyo Univ.); Fricke, K. Astron. Astrophys.; 21: No. 2, 285-90(Nov 1972).

The dynamical evolution of a 5.2×10^5 $M_\odot$ supermassive star is followed by solving numerically the general relativistic hydrodynamic equations. After initial quasistatic contraction general relativistic collapse below the static main-sequence radius takes place. The radiation pressure which is built up during the collapse phase by fast HCNO burning halts and reverses the collapse into a violent explosion which results in the complete dispersion of the star. Together with the results of an earlier paper it is concluded that—unless exotic damping mechanisms are invoked—relaxation oscillations as proposed by Fowler cannot occur in nonrotating supermassive stars. The kinematics and energetics of the explosion suggest that a possible mechanism is found which may serve to explain the explosion phenomena in peculiar galaxies like M 82 and NGC 1275. (auth)

10207 THERMAL ARC PLASMAS AS RADIATION SOURCES. Goldbach, C.; Nollez, G.; Peyturaux, R. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 21: No. 2, 299-302(Nov 1972).

A description is given of recent work on the use of thermal arc plasmas as radiation sources, for the calibration of light intensities in astrophysics (ultraviolet region) and for the metrology of high temperatures (determination of fixed points). A distinction is made between reference sources which must be calibrated using primary standards of lower temperature, and the primary standards themselves. The different possible approaches to the problem are considered. They can be classified as a function of the optical thickness characteristics of the plasma studied. (W.D.M.)

10208 V 745 CENTAURI. Saraber, M. J. M. (Leiden Observatory). Astron. Astrophys.; 21: No. 2, 311-12(Nov 1972).

From an investigation on Franklin Adams plates, the star V 745 Centauri (HD 126344) was found to be an eclipsing binary with a period of 3.025101d. The secondary minimum of the light-curve appeared to be wider than the primary one. (auth)

10209 NEW OH SOURCES ASSOCIATED WITH IR-LATE-TYPE STARS. Fillit, R. (Observatoire, Meudon, France); gheudin, M.; Nguyen-Quang-Rieu; Paschenko, M.; Slysh, V. Astron. Astrophys.; 21: No. 2, 317-19(Nov 1972).

A search for OH emission from IR-late-type stars resulted in the detection of four new sources. Their radio characteristics are similar to those of the class of the OH main-line emitters. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 9777, 10163, and 10707.

10210 COSMIC X-RAY SPECTRA. Pounds, K. A. (Univ. of Leicester, Eng.). Space Sci. Rev.; 13: No. 4-6, 871-89(1972).

Nearly 100 cosmic x-ray sources have now been observed, remarkable in both their luminosities ($Lx = 10^{36}-10^{46}$ ergs s^{-1}) and apparent variety. Observations were made with proportional counters at photon energies below 20 keV and with scintillation counters between 20 and 1000 keV. Spectra have generally been compared with either an exponential or power law distribution, with the aim of establishing a thermal bremsstrahlung (exponential) or synchrotron/inverse Compton (power law) emission mechanism, with no definite case of emission mechanism established. Thermal and non-thermal emission processes are described and the best available data are described for Scorpius X-1; supernova remnants Cygnus Loop, Vela X, and Puppis A; Crab Nebula; extragalactic sources of Magellanic Clouds, M87, Seyfert galaxies NGC 1275(32,41) and 4151 (32), the quasar 3C 272 (33), radio galaxy Gen-A (33), Comet Cluster (34); and the diffuse background radiation. (68 references). (J.C.W.)

10211 INFRARED SOURCES IN THE H II REGION W3. Wynn-Williams, C. G.; Becklin, E. E.; Neugebauer, G. (California Inst. of Tech., Pasadena). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 1-14(1972).

High resolution mapping and photometric observations in the wavelength range 1.65 to 20 μ have led to the discovery of nine distinct infrared objects in W3. Four of them, including one coincident with W3(OH), are identified with compact radio H II condensations ~0.1 pc in diameter. They show strong emission in the range 3 to 20 μ which is attributable to dust grains at a temperature of ~150 K mixed with the ionized gas. On the other hand, the 2-μ emission from these objects is considerably less than is predicted from the radio measurements, indicating that the H II condensations are surrounded by obscuring dust with up to 50 mag of visual extinction. One of the condensations contains an unresolved source which is almost certainly a highly obscured O star that excites the component. Four other infrared sources have no associated radio continuum source; one of these, an unresolved source with a luminosity $\sim 3 \times 10^4$ L, is coincident with a source of H_2O maser emission and may be a massive protostar. (auth)

10212 DETECTION OF 10 TO 100 MeV γ-RAYS FROM CRAB NEBULA PULSAR NP 0532. Albats, P.; Frye, G. M.; Zych, A. D.; (and others) (Case Western Reserve Univ., Cleveland). Nature (London); 240: No. 5378, 221-4(24 Nov 1972).

Pulsed γ-ray emission from NP 0532 has been detected up to 100 MeV. For the main pulse from 10 to 30 MeV the signal to noise is (5 to 6σ). The energy spectrum of the main pulse from 1 keV to 100 MeV can be fitted by a single power law of index (−0.9). (auth)

10213 B AND V PHOTOMETRY OF CYGNUS X-I. Walker, E. N. Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 9P-12P(1972).

B and V photometry of HDE 226868 (= Cygnus X-1) is presented. The star is variable with two maxima and two minima per radial velocity period. The variations indicate that at least one of the stars present in the binary system is not a normal star. (auth)

10214 PULSAR ASSOCIATED WITH THE SUPERNOVA REMNANT IC 443. Davies, J. G.; Lyne, A. C.; Seiradakis, J. H. (Univ. of Manchester, Eng.). Nature (London); 240: No. 5378, 229-30(24 Nov 1972).

During the period July to September 1972 the Jodrell Bank Mark 1A radio telescope was used in a systematic search for pulsars at a frequency of 408 MHz. Eighteen new pulsars were discovered, data for which are shown tabulated and pulse profiles shown graphically. The pulsar PSR 0611 + 22 lies about 0.6° from the center of the supernova remnant IC 443, and its dispersion measure is 99 pc/cm^3, that for the Crab Nebula being 57 pc/cm^3. There is a large H II region in the neighborhood of IC 443, which may contribute considerably to the dispersion measure of PSR 0611+ 22, and the distance inferred from the dispersion measure is not discordant with that quoted for IC 443, and in view of the period measurements, association of the pulsar with the supernova remnant appears clear. (UK)

10215 SEARCH FOR ISOLATED RADIO PULSES FROM THE CRAB NEBULA AT 151.5 MHz. Meikle, W. P. S.; Drever, R. W. P.; Haynes, R. F.; (and others) (Univ. of Glasgow). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 5P-8P(1972).

A search has been made for large bursts of radio emission at 151.5 MHz from the direction of the Crab Nebula. In 605 hr of observation, no events exceeding a flux of 1.4×10^{-22} W m^{-2} Hz^{-1} were detected. This therefore sets an upper limit for the energy in radio pulses from the direction of the Crab Nebula which might be associated with the events recorded in the gravitational wave experiments of Weber (Phys. Rev. Lett.; 24: 276 (1970), and 25: 180 (1970). Implications of the results with regard to "strong pulses" and phase fluctuations in the periodic emissions from the pulsar NP 0532 are also examined. (auth)

10216 THERMAL CONDUCTIVITY AND HOT MAGNETIC POLES OF PULSARS. Smoluchowski, R. (Princeton Univ., NJ). Nature (London) Phys. Sci.; 240: No. 99, 54-6(20 Nov 1972).

It is usually assumed that the solid crust of pulsars has a very high and isotropic electrical as well as thermal conductivity, and it is interesting to inquire into the presence of anisotropic electrical and thermal magnetoresistance caused by the very high magnetic fields. For magnetoresistance to be important the lattice thermal conductivity must be a small fraction of the total thermal conductivity, so that the electronic contribution is dominant. Evaluation of these conductivities is discussed, and it is found that the effect of lattice conduction is negligible unless the magnetic field lowers the electronic contribution at least by two orders of magnitude. Two distinct regions of magnetoresistance can be recognized. It is concluded that for pulsars with a central density lower than about $1.5 + 10^{14}$ g/cm^3 the magnetic field will not lead to a magnetic breakdown. The discussion suggests that in most pulsars a magnetic breakdown does occur and that only the mechanism of magnetoresistance based on quantization of states is operative. In pulsars with central density higher than about 1.5×10^{14} g/cm^3 there will be, in the outer layers, an anisotropy of thermal conductivity of the order of 70 to 90, but this effect will vanish in the deeper layers of the crust, and it seems that anisotropy of the order of 50 to 100 can reasonably be expected in all pulsars, whether small or large. Data are tabulated for limiting fields for magnetic breakdown for various densities, and for temperatures of the magnetic poles and equator as a function of density. (UK)

10217 OPTICAL IDENTIFICATION OF GX 17 + 2. Tarenghi, M.; Reina, C. (Univ., Milan). Nature (London) Phys. Sci.; 240: No. 99, 53-4(20 Nov 1972).

As part of a systematic search for the optical counterparts of the better localized x-ray sources preliminary results of a study of GX 17 + 2 (2U 1813-14) are reported. This source has a thermal spectrum and shows variations in both intensity and temperature. A striking resemblance has been noted in the x-ray emission of GX 17 + 2 and Sco X-1, and there is evidence for absorption effects at low x-ray energies. A weak variable radio source has recently been found that can be associated with GX 17 + 2, and on the assumption that GX 17 + 2 and the radio source are the same object a search was made for optical counterparts in the error box furnished by the radio observations. Assuming that GX 17 + 2 is of the same nature as Sco X-1, and that the absorption of x rays at the lower energies is due to interstellar absorption between source and observer, an estimate can be made of the apparent magnitude of its optical counterpart, leading to the conclusion that the latter is too faint to be observed. Alternative hypotheses on the nature of the x-ray source are also considered. Object 28 on the Palomar Sky Survey prints cannot, however, be ruled out as a possible optical candidate. (UK)

10218 SPECTROSCOPIC TECHNIQUES IN X-RAY ASTRONOMY. Van Speybroeck, Leon (American Science and Engineering, Cambridge, MA). Space Sci. Rev.; 13: No. 4-6, 845-69(1972).

The catalog of x-ray sources now includes types I and II supernovae remnants, at least one pulsar, other periodic or quasi-periodic sources, starlike objects that emit primarily in x rays, normal galaxies, radio galaxies, Seyfert galaxies, a quasar, and an apparently isotropic extragalactic background. The most useful energy range for x-ray observations extends from about

200 eV to perhaps 10 keV. The low energy limit results from the absorption by the interstellar media, which of course varies from object to object. Observations outside of this energy range are required to definitively identify a dominant source mechanism. The source mechanisms usually considered include synchrotron emission, inverse compton scattering, thermal emission from an optically thin hot gas, and blackbody radiation. The interstellar absorption significantly modifies the intrinsic source spectra. Relatively crude measurements suffice to distinguish between the principal source models and to determine their few parameters if line emission is unimportant. 43 references. (J.C.W.)

10219 PAIR-PRODUCING ELECTRIC FIELDS AND PULSARS. Parker, Leonard (Univ. of Wisconsin, Milwaukee); Tiomno, J. Astrophys. J.; 178: No. 3, 809-17(15 Dec 1972).

A system is considered in which a pair-producing electric field surrounding a central body gives rise to an oscillating coherent plasma of electron–positron pairs. A greatly simplified treatment of the model yields results indicating that there might possibly be some relation to pulsars. It is assumed that an equilibrium has been reached in which the energy of the new pairs is radiated away during the periods of significant pair creation. This crude model leads to expressions for the pulse half-width, lengthening of period, and power output, depending essentially on only one parameter proportional to the field amplitude, which is constant for periods from 10^{-2} to 10 s. Surprisingly, the above expressions lead to values which agree well with the corresponding observed quantities for pulsars. (auth)

10220 SEARCH FOR CORONAL LINE EMISSION FROM THE CYGNUS LOOP. Kurtz, D. W. (Univ. of Texas, Austin); Vanden Bout, P. A.; Angel, J. R. P. Astrophys. J.; 178: No. 3, 701-6(15 Dec 1972).

The flux from the edges of the Cygnus Loop in the coronal line [Fe XIV] λ5303 was measured to be less than 5×10^{-9} ergs cm^{-2} $sterad^{-1}$ s^{-1} (0.017 R) in a 3 Å band centered on the line. This upper limit is an order of magnitude lower than the predicted total flux in the line and implies that there must be substantial broadening of the line profile by mass motion or that the temperature is somewhat higher than the present best estimate from x-ray data. (auth)

10221 STUDIES OF SMALL H II REGIONS. I. INFRARED PHOTOMETRY OF SHARPLESS 138, 152, AND 270. Frogel, J. A.; Persson, S. E. (Harvard Coll. Observatory, Cambridge, MA). Astrophys. J.; 178: No. 3, 667-72(15 Dec 1972).

Multiaperture photometric observations from 1.6 to 3.5 μ of three small H II regions, Sharpless 138, 152, and 270, are presented. These three objects are shown to be representative of a distinct class of H II regions. The spatial and spectral distributions of the flux are similar for the three objects: surface brightnesses and apparent color temperatures generally decrease with increasing distance from the infrared centers. The integrated colors are: [1.6 μ] – [2.2 μ] ~ 1.0 mag, [2.2 μ] – [3.5 μ] ~ 2.4 mag, similar to those of NGC 7027. A plausible interpretation of the observations is that the infrared flux arises from a mixture of recombination emission and thermal radiation from dust particles. The 3.5-μ limb-brightening observed in Sh 152 could indicate the presence of a dust shell with an inner radius of ~16″. (auth)

10222 DECIMETER-WAVELENGTH OBSERVATIONS OF RADIO RECOMBINATION LINES IN W51. Parrish, A. (Arecibo Observatory, Puerto Rico); Pankonin, V.; Heiles, C. E.; Rankin, J. M.; Terzian, Y. Astrophys. J.; 178: No. 3, 673-80 (15 Dec 1972).

The 1000-foot (305-m) Arecibo telescope was used to detect the 221 and 248α hydrogen and the 248α anomalous (carbon) recombination lines from the galactic radio source W51. The half-power widths of the detected lines are proportional to their radio frequencies; they exhibit no pressure broadening. (auth)

10223 DISTRIBUTION OF REDSHIFTS OF QUASI-STELLAR OBJECTS AND RELATED EMISSION-LINE OBJECTS. Burbidge, G. R.; O'Dell, S. L. (Univ. of California, San Diego). Astrophys. J.; 178: No. 3, 583-605(15 Dec 1972).

A list of all published redshifts of quasi-stellar objects and related compact objects with strong emission-line spectra is given in a table. The distribution of all the redshifts and those of various subsets thereof was subjected to several statistical tests in order to determine whether they are consistent with the hypothesis of randomness on a scale $\Delta z < 0.1$. A power-spectrum analysis of all the redshifts yields a spectral maximum, corresponding to a wavelength of 0.0705 in z, which may be considered significant at a 97.5% confidence level. Due to a large residual phase indicated by the Fourier analysis, it is suspected that this spectral maximum does not reflect a true periodicity, but rather results from interference of several random peaks in the distribution of redshifts. The peaks themselves are consistent with local ($\Delta z < 0.1$) randomness except for $z \lesssim 0.1$. For small redshifts $z \lesssim 0.2$, most of the objects are compact emission-line objects but not genuine QSOs. A power-spectrum analysis of distribution of the non-QSO redshifts gives a spectral maximum, corresponding to a wavelength of 0.031 in z, which also is considered significant at a 97.5% confidence level. In this case, the small residual phase present in the Fourier analysis is not in conflict with a true, though rather dispersed, periodicity. This spectral maximum is due largely, though not exclusively, to two peaks in the distribution of redshifts near z = 0.03 and 0.06. These two peaks together (though not separately) are statistically significant at about 98% confidence. It appears that this periodicity is that originally suggested as a 0.061 periodicity by G. R. Burbidge, and as 0.0625 in the analysis by Cowan. Finally, it is pointed out that any very sharp periodicity due to intrinsic redshift components in extragalactic objects will tend to be smeared by the cosmological redshift components and Doppler shifts due to random motions. (auth)

10224 ABSORPTION LINES IN THE SPECTRUM OF THE QUASAR TON 1530. Morton, W. A.; Morton, D. C. (Princeton Univ., NJ). Astrophys. J.; 178: No. 3, 607-15(15 Dec 1972).

Two spectra of the quasar Ton 1530 (z_{em} = 2.047) were obtained with the Princeton integrating television system at the coudé focus of the 200-inch (508-cm) telescope. The first spectrum covered the region of 4435 to 4655 Å with 0.87 Å resolution; and the second one, obtained a year later, covered essentially the same range with 0.52 Å resolution. The principal features are two sets of C IV resonance doublets in absorption, which had been reported in previous lower-resolution observations. Each member of the shorter-wavelength doublet was found to split into three components with redshifts z = 1.9358, 1.9371, 1.9384. The Doppler width in each of these three clouds is probably less than 40 km s^{-1}. The longer-wavelength doublet at z = 1.9803 still appears to be due to a single cloud with a Doppler width in the range of 60 ± 20 km s^{-1} and a column density of ~1.2×10^{14} C IV ions cm^{-2}. (auth)

10225 UBV OBSERVATIONS OF 3C 273 V. Burkhead, M. S.; Rettig, T. W. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 84: No. 502, 850(Dec 1972).

UBV observations of 3C 273 for 1972 are presented. The data indicate erratic variations of the V magnitude of 3C 273 with an amplitude of approximately 0.15 m. (W.D.M.)

10226 VARIATIONS IN THE 8 GHz FLUX DENSITY AND LINEAR POLARIZATION OF EXTRAGALACTIC RADIO SOURCES. Olsen, E. T. Ann Arbor, MI; Univ. of Michigan (1972). 132p. University Microfilms Order No. 72-29,162.

Thesis.

The linear polarization of radio sources which exhibit variations in flux density has been monitored at 8 HGz since 1965 with the University of Michigan 85-foot reflector equipped with a rotating linearly polarized feed horn. Significant variations have been detected in the total flux density and linearly polarized emission of radio sources 4C39.25 and BL Lacertae, and continued variations have been observed in 3C120, 3C273, 3C279, 3C345, and 3C454.3. The time scale for these variations has ranged from less than one week in the case of BL Lacertae to more than four years for 4C39.25. Comparison of the polarization observations with the small-scale structure observed by very-long-baseline interferometry reveals that variable polarization is closely correlated with the structure of the compact sources. For example, the polarization position angles of the radio sources 3C120 and 3C273 have on the average been almost perpendicular to the line of separation of the compact double components detected within the sources, implying that the polarized emission of the variable components in these two objects originates in a volume whose magnetic field is generally oriented parallel to the line of separation of the double sources. The radio sources 3C279 and 4C39.25 have exhibited a change of 90 degrees in their polarization position angles during the time period of the observations. This may imply that the magnetic field structure contained within these sources has changed. A model similar to that which has previously been used to explain the polarization of radio galaxies which have double components has been found to be applicable to 3C279. This model involves the compression of the magnetic field along the leading surfaces of the two components which are separating at relativistic speeds. This compression results in regions of enhanced emission with the magnetic field lines oriented perpendicular to the line of separation. If the same model can be applied to 4C39.25, very-long-baseline interferometry should eventually reveal a separating double source whose line of separation is oriented at ϕ = 50 degrees. (Diss. Abstr. Int., B)

10227 SYNTHESIS OF THE POLARIZATION PROPERTIES OF CYGNUS A AT 8300 AND 9600 MEGAHERTZ. Yip, K. B. W.

Pasadena, CA; California Inst. of Tech. (1972). 150p. University Microfilms Order No. 72-30,842.

Thesis.

Methods of polarized interferometry were used in conjunction with the earth rotation aperture synthesis technique to study the polarized intensity distributions of Cygnus A at 8300 and 9600 MHz. The total intensity distribution at 8300 MHz was also obtained. Although the resolutions obtained in these observations were about 20'', it was still quite insufficient to reveal the structures in the components for a detailed comparison with the theoretical model proposed by Mills and Sturrock. The general feature of the ram pressure confinement mechanism, however, is consistent with this observation. The polarized distributions yielded a rather fast variation of large rotation measures across the east component. There was also a reversal of the longitudinal magnetic field in the direction of the west component. Correlations with the distribution of small hydrogen clouds deduced from HI absorption measurements are discussed. There seemed to be little depolarization across this source except in the bridge, and this was believed to be occurring outside of the emitting region. However, no detailed models can be worked out without further information about the conditions of the intervening medium. (Diss. Abstr. Int., B)

10228 RECOMBINATION LINE EMISSION FROM GALACTIC H I AND H II REGIONS. Cesarsky, D. A. Cambridge, MD; Harvard Univ. (1972). 69p. University Microfilms Order No. 72-15,055.

Thesis.

Radio recombination lines are emitted as a result of electronic transitions between high quantum number energy levels, $n \gtrsim 60$. Electrons reach these levels either by direct recombination from the continuum—hence the name of the line emitting process—or by cascade from even higher levels. The role played by collisional processes is determined by the electron density and the quantum number of the level considered. In general, collisional processes become more important at higher n numbers. Radio recombination emission is a manifestation of ionized matter, and therefore provides a new tool to investigate a large fraction of the Universe. To date, recombination line observations have dealt mostly with H II regions in the galaxy. Consequently, most theoretical work is aimed towards interpreting the line emission from hot and dense plasmas. Recently, radio astronomers have begun to realize that other objects may also be studied by means of recombination line observations. In particular, an H I region has been observed (Ball et al., 1970, Cesarsky 1971), as well as line radiation that is very likely to originate in the interstellar medium (Gottesman and Gordon, 1970). There is the theoretical possibility of detecting radio recombination line from the Sun, and perhaps supernova remnants (Dupree 1971). (Diss. Abstr. Int., B)

10229 DETECTION OF CYANOACETYLENE AT 18 GHz. Dickinson, D. F. (Smithsonian Astrophysical Observatory, Cambridge, MA). Astrophys. Lett.; 12: No. 4, 235-6(Dec 1972).

The principal hyperfine components of the $J = 2 \rightarrow 1$ rotational transition of cyanoacetylene were observed in Sgr B2. This result, coupled with the $J = 1 \rightarrow 0$ observations of Turner (1971), suggested that cyanoacetylene cannot be described by a simple LTE model. (auth)

10230 21-cm LINE ABSORPTION PROFILES OF FOUR PULSARS. Gomez Gonzalez, J.; Falgarone, E.; Encrenaz, P.; Guelin, M. (Observatoire, Meudon, France). Astrophys. Lett.; 12: No. 4, 207-9(Dec 1972).

21-cm line spectra were observed in front of the pulsars PSR 0628 − 28, 1706 − 16, 1929 + 10, and 2021 + 51. Absorption was detected in the directions of PSR 1706 − 16 and 1929 + 10 near to the local-standard-of-rest velocity. No lower limit could be derived for the distances of these sources. Tentative upper limits of 1 kpc were set for PSR 1929 + 10 and 2021 + 51. (auth)

10231 FOUR VARIABLE RADIO SOURCES AT 408 MHz. Hunstead, R. W. (Univ. of Sydney). Astrophys. Lett.; 12: No. 4, 193-200(Dec 1972).

Evidence is presented for large fractional variations in the 408-MHz emission from two quasi-stellar objects (CTA 102 and 3C 454.3) and two radio galaxies (PKS 1504 − 16.7 and 1524 − 13). In each source significant changes in flux density have occurred on a time scale of a few months. If the variations observed at 408 MHz are intrinsic to the radiating regions, they raise some important astrophysical questions concerning the physical processes operating in nonthermal radio sources. (auth)

10232 RADIO COMPONENTS WITH A CIRCUMFERENTIAL MAGNETIC FIELD CONFIGURATION IN 3C 219 AND 3C 353. Fomalont, E. B. (National Radio Astronomy Observatory, Green Bank, WV). Astrophys. Lett.; 12: No. 4, 187-92(Dec 1972).

The linearly polarized distribution for the radio sources 3C 219 and 3C 353 at 2695 MHz are presented. Both sources show evidence for a circumferential magnetic field associated with one of their components. These components are extended perpendicular to the major axis of the radio source. Such a magnetic field configuration may have some bearing on the confinement and evolution of the source components. (auth)

10233 KINEMATICAL DISTRIBUTION OF DARK CLOUDS SURVEYED IN THE 4830 MHz H_2CO LINE. Minn, Y. K. (Max-Planck-Institut fuer Radioastronomie, Bonn); Greenberg, J. M. Astron. Astrophys.; 22: No. 1, 13-25(Jan 1973).

A survey of over 80 dark clouds was made for formaldehyde absorption using the 140-foot telescope of the National Radio Astronomy Observatory. Most of the clouds were selected from Lynds' Catalogue of Dark Clouds. Additional ones were chosen from the Palomar Sky Atlas. The useful velocity range coverage was from about +60 to −60 km/s. Many of the clouds showed up with two or more distinctly separate velocity components. The dust clouds seemed to be well correlated with HI emission peaks whether in spiral arms or spurs. Where comparisons were possible it was found that OH and H_2CO coexist. On the basis of their velocities the dust clouds are shown to be the same objects as the molecular clouds. The random velocities of the dark clouds were about 5 km/s. The average line-width was about 1.1 km/s. The opaque clouds and clouds with the filamentary structure observed had the sharpest and most intense absorption. (auth)

10234 FURTHER EVIDENCE FOR A BLACK HOLE IN BETA LYRAE. Kondo, Y.; McCluskey, G. E.; Houck, T. E. (Manned Spacecraft Center, Houston, TX). Nature (London) Phys. Sci.; 240: No. 101, 119-20(4 Dec 1972).

A reply is given to the comments of Wilson (Nature 234: 408 (1971)) on the present authors' paper on the OAO-2 observations of Beta Lyrae published in Proc. OAO symposium, August 1971. (UK)

10235 CIRCULAR POLARIZATION OF SCO X-1 AND THE ADJACENT SKY. Kemp, J. C. (Univ. of Hawaii, Honolulu). Nature (London) Phys. Sci.; 240: No. 101, 103-4(4 Dec 1972).

Questions arise regarding possible circular polarisation of light from the x-ray star Sco X-1. Some recent data obtained by the author in the red pass band λλ 5,500 to 6,800, using the photoelastic polarimeter on the Mauna Kea Observatory 224 cm telescope, are discussed. The pattern was essentially consistent with random noise, although there was an apparent "flare" on September 11, 1972, and there was an indication of a non-Gaussian noise distribution not typical of polarimetric records for other objects. The case for polarisation flares, however, is feeble since the aggregate sampling time was only a few hours. It was suspected that polarised sky effects may have been a factor in some of the observations, and measurements indicated the largest value yet detected for the night sky in the absence of moonlight or similar contamination. The most obvious source for this large polarisation is the zodiacal light, but it seems impossible to account for the large circular polarisation in this way, unless the value rises rapidly in the red; if it does not it must be surmised that some other strong source of circularly polarised light is or was present in the sky around Sco X-1. The unusually strong circular polarisation in the region of Sco X-1 may be only coincidence, however, and a matter of nearness to the ecliptic. (UK)

10236 FURTHER REMARKS ON SELECTION EFFECTS IN SPECTROSCOPIC OBSERVATIONS OF QSOs. Roeder, R. C.; Dyer, C. C. (Kitt Peak National Observatory, Tucson, AZ). Nature (London) Phys. Sci.; 240: No. 101, 104-5(4 Dec 1972).

A reply is given to criticisms by Wills (Nature Phys. Sci. 238: 70 (1972)) of the authors' suggestion (loc. cit. 235: 3 (1972)) that the distribution of quasar redshifts may be significantly affected by observational selection effects and that consequently no conclusions should be drawn from raw distributions. These criticisms are not accepted. (UK)

10237 NEW AND IMPROVED PARAMETERS FOR TWENTY-TWO PULSARS. Manchester, R. N.; Taylor, J. H.; Huguenin, G. R. (Univ. of Massachusetts, Amherst). Nature (London) Phys. Sci.; 240: No. 100, 74-5(27 Nov 1972).

Observations made with the 92 m telescope of the National Radio Astronomy Observatory have resulted in improved positions, periods, period derivatives, dispersion measures, and pulse widths for a number of recently discovered or weak pulsars. The new data are presented in tabular form. (auth)

10238 I Zw 1727 + 50. A NEW LACERTID. LeSqueren, A. M.; Biraud, F.; Lauque, R. (Observatoire de Paris, Meudon, France). Nature (London) Phys. Sci.; 240: No. 100, 75-6(27 Nov 1972).

It is suggested that BL Lac, AP Lib, W Coma, OJ 287, and B2 1215 + 30 belong to a new class of objects, that might be termed lacertids, from BL lacertae, the first discovered and most extensively studied. Their main characteristics are: a featureless optical spectrum; a rather flat or even inverted radio spectrum; and very fast and irregular variations both at radio and optical wavelengths. The object I Zw 1727 + 50 was detected at 4,850 MHz using the Nançay radio telescope, and also measured at 1,420 and 2,700 MHz. The mean right ascension was in good agreement with the optical position measured from the Palomar Sky Survey print, and the spectral index was −0.26, that of known lacertids ranging from −0.30 to +0.40 at decimetric wavelengths. The spectrum is continuous and its energy distribution closely resembles that of the five known lacertids. The previously known optical properties of I Zw 1727 + 50 are similar to those of BL Lac and related objects and measurements of its radio flux strongly support the hypothesis that it is a new member of the lacertid class; it would be interesting to search for radio variations. The known lacertids have been found more or less by chance, but it seems likely that a large number could be found in a systematic search. (UK)

10239 INTERFEROMETRIC SURVEY OF THE AREAS SURROUNDING FOUR INTENSE RADIO SOURCES. Peckham, R. J.; Palmer, H. P. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London) Phys. Sci.; 240: No. 100, 76-7(27 Nov 1972).

The results of an interferometric survey of the areas surrounding the intense radio sources Cassiopeia A, Cygnus A, Taurus A, and Virgo A are reported. The observations were made in August 1971 using the Mk II and Mk III radio telescopes at Jodrell Bank. Use of a long-baseline radio link interferometer had the advantage that sidelobe responses were reduced by several orders of magnitude, since the intense sources were well resolved. The initial search detected one source in the vicinity of Cas A and two near Cyg A. Four sources were detected near Taurus A, one of which coincided with PKS 0531 + 19. Details are tabulated for all these new sources. It was unfortunate that the position measurements do not yield even tentative optical identifications for the new sources, since the area is heavily obscured. More accurate positions are needed before the possible association of these sources can be discussed further, and detailed measurements of their radio structures would also be of interest. (UK)

10240 PULSATIONAL DAMPING OF NEUTRON STARS. Heintzmann, H.; Nitsch, J. (Univ., Cologne). Astron. Astrophys.; 21: No. 2, 291-8(Nov 1972).

The damping of neutron star vibrations is reconsidered in the light of more recent, semirealistic neutron star models. It is assumed that the star possesses a strong magnetic field and that the interior is composed of essentially four components, namely an outer crust, a superfluid neutron and proton component, a normal neutron component and a quantum crystal. It is shown that both the magnetic field and the normal neutron fluid component give rise to damping of neutron star vibrations on a time scale of months or years while the damping in the lattice or superfluid part due to electron–proton or electron–electron scattering is estimated to be less effective by 2 to 4 orders of magnitude. Possible mechanisms by which vibrations can be triggered over astronomical timescales are reviewed and a discussion of how other damping mechanisms previously discussed in the literature are affected through the more recently obtained results of neutron star matter is given. As a by-product of the calculations the specific heat and thermal conductivity are derived for normal neutron matter which might be important for the cooling of hot neutron stars. (auth)

10241 MODEL OF THE CRAB NEBULA DERIVED FROM DUAL-FREQUENCY RADIO MEASUREMENTS. Weiler, K. W. (Radiosterrenwacht Westerbork, Post Hooghalen, Netherlands); Seielstad, G. A. Astron. Astrophys.; 21: No. 3, 393-400(Dec 1972).

The total intensity and linearly polarized emission from the Crab Nebula were synthesized to a resolution of approximately 1 arc-minute at both 1420 and 2880 MHz. From these data were calculated the spectral index, rotation measure, intrinsic position angle, and depolarization ratio distributions. Then, combined with a source model, the physical conditions within the supernova remnant were established. The strength and orientation of both the homogeneous and random components of the magnetic field were determined and a measurement of the thermal electron plasma distribution obtained. (auth)

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Refer also to abstracts 10332, 10707, and 11144.

10242 (AD–744958) ANALYSIS OF THE 1966 SOLAR ECLIPSE DATA. Final Report, April 1, 1970–November 30, 1971. Sears, R. D. (Lockheed Missiles and Space Co., Palo Alto, Calif.). 29 Feb 1972. Contract DASA01-70-C-0101. 96p. (LMSC-D-246526; DNA-2863-F). NTIS.

A study of the effects of the November 12, 1966 total solar eclipse on the ionosphere was conducted. The various sources of ionization in the D and E regions were determined from measurements made during the eclipse period and from analytical models. In addition, the eclipse-induced variations in the strength of the ionization source function with altitude during the eclipse was modeled. Ionospheric measurements of positive ion species and total density, electron density, and O_2 (singlet $\Delta(g)$) density and their variations during the eclipse were placed on a common eclipse-referenced coordinate system and these data were combined with a consistent data base for further studies. (auth)

10243 DIELECTRONIC SATELLITE SPECTRA FOR HIGHLY-CHARGED HELIUM-LIKE ION LINES. Gabriel, A. H. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 99-119(1972).

Calculations have been carried out in intermediate coupling of the wavelengths and intensities of the satellite lines situated on the long wavelength side of the helium-like ion resonance lines, recently observed from solar flares. Earlier calculations up to aluminium have been extended up to iron and copper. For the intensities, the important processes are primarily dielectronic recombination, but also direct inner-shell excitation. Comparisons have been made with spectra from solar flares and active regions, and from low-inductance laboratory sparks. Computed wavelengths in iron are found to agree with these to better than 0.0003 Å. Comparison of the intensities allows the determination of both the electron temperature and the transient ionizing state of the plasma. The laboratory plasma spectra are found to be in an extreme transient ionizing condition, and are thus significantly different from solar spectra. In the cases studied, solar active regions were found to be moderately ionizing, while the flare spectra were recombining. (auth)

10244 EFFECTS OF UNCERTAINTIES IN DAMPING AND MICROTURBULENCE ON THEORETICAL DEDUCTIONS FROM SOLAR EQUIVALENT WIDTHS. Blackwell, D. E.; Calamai, G.; Willis, R. B. (Oxford Univ.). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 121-7(1972).

A quantitative discussion is presented of the effect on the interpretation of the equivalent widths of solar lines, of present uncertainties in damping constants and in atmospheric microturbulence. Graphs are given showing the resultant uncertainty in the interpretation of equivalent widths as a function of excitation potential and wavelength. (auth)

10245 SOLAR PROTON INTENSITY STRUCTURES IN THE MAGNETOSPHERE DURING INTERPLANETARY ANISOTROPIES. Morfill, G.; Scholer, M. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Planet. Space Sci.; 20: No. 12, 2113-23(Dec 1972).

Detailed comparisons of measured solar particle structure in the magnetosphere during interplanetary anisotropies are made with the predictions of open tail models and diffusion calculations. Using observed and predicted intensity structures and their time variations, it is found that the nonadiabatic reconnection model shows the closest agreement with observations in all cases so far examined. (auth)

10246 DIELECTRONIC SATELLITE SPECTRA IN THE SOFT X-RAY REGION. Gabriel, A. H. (Culham Lab., Abingdon, Eng.). Space Sci. Rev.; 13: No. 4-6, 655-64(1972).

Satellite lines, situated on the long wavelength side of the helium-like ion resonance line, can be observed in highly ionized ions both in laboratory sources and from the Sun. Although seen for more than 30 years, these lines have only recently been classified in detail as inner-shell transitions in lithium-like ions. Laboratory experiments have shown that, under steady-state conditions, these satellites are produced by dielectronic recombination, although in transient ionizing plasmas, direct inner-shell excitation can be important. Detailed calculations have been carried out for high-Z ions up to copper, and the results can be compared with solar flare spectra in iron. Such comparisons allow both the electron temperature and the transient state of the plasma to be determined. Laboratory spectra from such high-Z ions are different in appearance, and may be dominated by processes resulting from the transient ionizing state of the plasma. (27 references). (auth)

10247 SOLAR EUV-EMITTING PLASMA. Noyes, R. W. (Smithsonian Astrophysical Observatory, Cambridge, MA); Withbroe, G. L. Space Sci. Rev.; 13: No. 4-6, 612-37(1972).

Many different ways of analyzing the structure, excluding fine structure, of the solar atmosphere from its euv emission are considered. The wavelengths considered are between 300 to 3000 A. The considerations involving the quiet solar atmosphere studied include mean temperature profile of the chromosphere and corona; direct measurements of heights in the solar atmosphere; density determinations in the solar atmosphere; chemical composition of the transition zone and lower corona; and energy balance and the problem of inhomogeneities. The structure of active regions studied from euv data include active regions in the chromosphere; active regions in the transition zone and low corona; and "holes" in the corona. In the wavelength region studied, the lower end is close to the practical limit of normal-incidence optics, and the upper end is the approximate limit of visibility from Earth's surface. 67 references. (J.C.W.)

10248 IDENTIFICATIONS OF EMISSION LINES IN THE EUV SOLAR SPECTRUM. Jordan, Carole (Culham Lab., Abingdon, Eng.). Space Sci. Rev.; 13: No. 4-6, 595-605(1972).

Solar-line identifications are made on lines that appear only in the solar disk, thus excluding lines from low stages of ionization at wavelengths of above about 2000 A that can appear in emission at the limb. The solar spectrum is studied in wavelength regions of 1.5 to 44 A; 40 to 170 A; 170 to 240 A; 240 to 450 A; 450 to 1100 A; 1100 to 2200 A. The types of transitions that occur appear over restricted wavelength ranges. (47 references). (J.C.W.)

10249 TRANSIENT HIGHLY EXCITED SOLAR-FLARE PLASMA. de Feiter, L. D. (Astronomical Inst., Utrecht). Space Sci. Rev.; 13: No. 4-6, 827-42(1972).

Recent observations of the energetic particles produced in solar flares indicate that the production of electrons, with energies up to about 100 keV, is a fairly common feature of small flares. In those flares the acceleration of protons and other nuclei does not extend beyond about 1 MeV. The x-ray emission often exhibits two distinct components of which the first one is produced by non-thermal, the second by thermal electrons through bremsstrahlung collisions with the ambient ions. Along with these x rays, radio emission, in the microwave region, is observed. This radio emission is usually interpreted as due to gyrosynchrotron radiation from the same electrons. A discussion is presented of the processes occurring in solar flares with special reference to the acceleration and radiation processes. 67 references. (auth)

10250 SOLAR-FLARE PLASMA: OBSERVATION AND INTERPRETATION. Doschek, G. A. (Naval Research Lab., Washington, DC). Space Sci. Rev.; 13: No. 4-6, 765-821(1972).

In the past several years, x-ray observations of the Sun made from rockets and satellites have demonstrated the existence of high temperature ($\sim 20 \times 10^6 - \sim 100 \times 10^6$ K), low density plasmas associated with solar-flare phenomena. In the hard x-ray range ($\lambda \lesssim 1$ Å), spectra of the flaring plasma have been obtained using proportional and scintillation counter detectors. It is possible from these data to determine the evolution of the hard x-ray flare spectrum as the burst progresses; and by assuming either a non-thermal or thermal (Maxwellian) electron distribution function, characteristic plasma parameters such as emission measure and temperature (for a thermal interpretation) can be determined. Thermal interpretation) can be determined. Thermal interpretations of hard x-ray data required temperatures of $\sim 100 \times 10^6$ K. In contrast, the soft x-ray flare spectrum (1 Å $< \lambda <$ 30 Å) exhibits line emission from hydrogen-like and helium-like ions, e.g., Ne, Mg, Al, Si, ... Fe, that indicates electron energies more characteristic of temperatures of $\sim 20 \times 10^6$ K. Furthermore, line intensity ratios obtained during the course of an event show that the flare plasma can only be described satisfactorily by assuming a source composed of several different temperature regions; and that the emission measures and temperatures of these regions appear to change as the flare evolves. Temperatures are determined from line ratios of hydrogen-like to helium-like ions for a number of different elements, e.g., S, Si, and Mg, and from the slope of the x-ray continuum which is assumed to be due to free-free and free-bound emission. There is no obvious indication in soft x-ray flare spectra of non-thermal processes, although accurate continuum measurements are difficult with the data obtained to date because of higher order diffraction effects due to the use of crystal spectrometers. Soft x-ray flare spectra also show satellite lines of the hydrogen-like and helium-like ions, notably the $1s^2 2s\,^2S - 1s2s2p\,^2P$ transition of the lithium-like ion, and support the contention that in low density plasmas these lines are formed by dielectronic recombination to the helium-like ion. Also, series of allowed transitions of hydrogen-like and helium-like ions are strong, e.g., the Lyman series of s up to Lyman-ϵ, and ratios of the higher member lines to the Lyman-α line can be compared with theoretical calculations of the relative line strengths obtained by assuming various processes of line formation. The x-ray spectrum of solar flares from ~250 keV to ~0.4 keV is discussed and is primarily concerned with the soft x-ray spectrum and the interpretation of emission lines and continuum features that lie in this spectral range. 88 references. (auth)

10251 LABORATORY-PRODUCED RADIATION RELATED TO THE SOLAR-FLARE EMISSION. Elton, R. C.; Lie, T. N. (Naval Research Lab., Washington, DC). Space Sci. Rev.; 13: No. 4-6, 747-60(1972).

A review is given of continuing efforts to generate laboratory spectra at photon energies above 1 keV from highly ionized atoms. Emphasis is placed on the most easily-interpreted highest ion stages such as the hydrogenic, helium-like, and lithium-like species. The close similarities to solar-flare observations of certain signatures, such as the line and continuum x-ray spectra and microwave emission as well as their sequence of occurrence, are pointed out and scaling factors are given. (auth)

10252 SOLAR X-RAY SOURCE UNASSOCIATED WITH SUNSPOTS. Gurzadyan, G. A.; Vartanyan, K. V. (Byurakan Astrophysical Observatory, Erevan). Space Sci. Rev.; 13: No. 4-6, 731-7(1972).

An investigation was made on Oct. 3, 1970 of the Sun in the region of short- and x-ray waves. X-ray isophotes are shown for this observation. Three occurrences of sources of x-ray radiation are observed and discussed for the time of the satellite-borne observations. Conclusions are made concerning the comparison of the isophotes and the general condition of the Sun at that time. The largest group of sunspots is not associated with a noticeable region of x-ray radiation. The most powerful x-ray source is not associated with the sunspots in any way. The maximum radiation of this source even lies beyond the Sun's limb. On the same day as the observations, the appearance of a prominence at the western end of the Sun's disk was registered at Abastumani Observatory. To sum up, at the time of the observations the most powerful x-ray source on the Sun can be associated with the appearance of the prominence, and the largest of the sunspot groups did not prove a source of x-ray radiation of the expected power. (J.C.W.)

10253 CORONAL X-SPECTRUM: PROBLEMS AND PROSPECTS. Walker, A. B. C. Jr. (Aerospace Corp., El Segundo, CA). Space Sci. Rev.; 13: No. 4-6, 672-730(1972).

The coronal spectrum provides a unique opportunity to probe atomic processes in a high temperature plasma. The corona is optically thin, at low density, and the coronal ions are highly stripped. These characteristics result in an emission line spectrum with a rich multiplet structure, with forbidden lines prominent in the spectrum, and deexcitation of metastable states by two photon decay making significant contributions to the continuum. The multiplet structure is further complicated by the presence of satellite lines from autoionizing states formed during recombination. With few exceptions, the true coronal lines are below 300 Å, and the general necessity for and complexity of grazing incidence optics has made it difficult to obtain high resolution spectroheliograms. The observational status is studied under the headings of the spectrum below 25 A; the spectrum from 25 to 400 A; the spatial distribution of the coronal emission; identification of spectral lines; and absolute intensity measurements. The theoretical basis for the interpretation of the observed spectra is studied under the headings of the population of excited states; the de-excitation of excited states; recombination process and the x-ray continuum; techniques for the direct measurement of physical parameters; and the relative importance of emission processes in the coronal spectrum. The subjects discussed under the heading of the structure of the quiet corona include elemental abundances; temperature structure; and density structure. Recent observational results are given and the prospects presented by the review are discussed. 224 references. (J.C.W.)

10254 EAST-WEST ASYMMETRY OF WHITE-LIGHT FACULAE. Bruning, D. H. (Kitt Peak National Observatory, Tucson, AZ). Publ. Astron. Soc. Pac.; 84: No. 502, 856-7(Dec 1972).

A study of the Greenwich Photoheliographic Results reveals that a greater percentage of the total faculae area is found on the eastern hemisphere of the Sun's surface than on the western hemisphere. This occurrence of a larger eastern faculae area has been termed the east–west asymmetry of white-light faculae. It is suggested that this east-west asymmetry is caused by a westward inclination of the facular surface normal to the solar radius. Appearing to be analogous with the inclination of sunspots as determined by Minnaert, the faculae inclination is approximately 0.4°. (auth)

10255 STUDY OF SOLAR-WIND STORMS: FEATURES DEDUCED FROM RADIO-PROPAGATION MEASUREMENTS OF

ELECTRON CONTENT. Landt, J. A. Stanford, CA; Stanford Univ. (1972). 118p. University Microfilms Order No. 72-30,655. Thesis.

In recent years, knowledge of the solar wind has increased rapidly, but few observations have been reported concerning the geometries of large-scale solar-wind disturbances that are known as blast waves, driven waves, and colliding streams. These and other disturbances characterized by large increases in density (solar-wind storms) are investigated through comparisons of single-location measurements to the average of the electron density obtained by radio signal delay measurements along a radiopath between Earth and interplanetary spacecraft. Previous studies indicate that blast and driven waves should have broad spherical structures, and this is confirmed for some events. Shapes of other solar-wind storms are derived, among which a new class of spatially limited storms is identified; these structures contain regions with densities greater than any observed in the broad storms. Mechanisms involved in the confinement and deceleration of these compact disturbances are examined, and it is determined that the ram pressure may be responsible for some of their properties. Several possible explanations are postulated for the observed spatial relationships between dense storms and colliding streams. A causal relationship between solar-wind storms and certain types of radio-noise bursts from the Sun has been proposed and is supported by comparisons made in this investigation. When storm geometries are ordered by the longitude of solar flares that were accompanied by radio-noise bursts, deviations from the expected pattern are observed. It is possible that nonradial ejection of material can originate from flare sites and that storm geometries can be distorted because of inhomogeneities in the velocity and density of the undisturbed wind. It is found that the size of a storm is approximately in inverse proportion to its density. (Diss. Abstr. Int., B)

10256 SOLAR INFRARED LIMB PROFILES. Johnson, N. J. Ann Arbor, MI; Univ. of Michigan (1972). 85p. University Microfilms Order No. 72-29,106. Thesis.

The results of measurements made at Kitt Peak National Observatory early in 1970 with the 91 cm and 160 cm mirrors of the McMath Solar Telescope are presented. A grating spectrometer was used with a liquid-helium-cooled bolometer to give spectral resolution better than 0.1 μm at 2.39, 4.63, 10.02. 13.42, and 19.08 μm. Dual 0.2 to 0.5 mm slits, separated by 7.4 cm, viewed alternately, provided good spatial calibration and some background rejection. Wavelength selection to avoid atmospheric absorption features resulted in very significant background rejection, especially at 19.08 μm. The data included scans extending several solar radii past the limb which were essential to the evaluation of scattering phenomena. Limb profiles were obtained at each wavelength extending to Cos θ = 0.05. Accuracy of measurement for Cos θ > 0.1 was generally better than one per cent. Comparison of the equatorial and polar profiles at 4.63 μm shows an enhancement of the equatorial limb that increases toward the disk edge, reaching an equivalent temperature difference of about 70°K at Cos θ = 0.1. The 10.02 μm data show a more rapid decline in temperature with increasing height than previous measures indicate, and the data at 19.08 μm suggest that the slope of the "plateau" of temperature in the transition region is steeper than presently believed, decreasing to a minimum of about 4420°K. There is a slight indication of brightening at the extreme limb in the 19.08 μm results. (TSS) (Diss. Abstr. Int., B)

10257 THEORETICAL INVESTIGATION OF THE STRENGTHS OF METAL LINES IN THE UMBRAE OF SUNSPOTS. Fullerton, L. W. Ann Arbor, MI; Univ. of Michigan (1972). 41p. University Microfilms Order No. 72-29,058. Thesis.

The Wilson effect and the anomalous strengths of some umbral spectral lines are investigated theoretically. The Wilson effect is defined to be the changes in appearance of a sunspot with changing heliocentric angle, and the observed changes are interpreted on the basis of cylindrically symmetric umbral, transition region, and penumbral atmospheric models whose boundaries are vertical. It is shown that the observations are consistent with a sunspot model in which the umbra is depressed approximately 1000 km with respect to the penumbra. Theoretically calculated intensity profiles are presented and compared with observation. It is suggested that a part of the cause for theoretical neutral umbral lines being too strong and theoretical ion lines being too weak is an increased ionization temperature in the umbra. The ionization temperature is greater than implied by continuum observations, because penumbral ultraviolet radiation reaches the higher umbral layers and ionizes neutral metal atoms. It is shown that although the penumbral radiation field does change the strengths of lines, the radiation field of just the umbra itself is important. It is also argued that the radiation field of the photosphere should be taken into account when photospheric line strengths of neutral metals are calculated. The effect of the penumbral radiation field is shown to be much smaller than the errors in currently available observations. These errors result primarily from stray light and from incorrectly estimating the umbral continuum. The method developed for quickly and accurately calculating the intensity integral is discussed in detail. (Diss. Abstr. Int., B)

10258 DYNAMO ACTION OF THE GLOBAL CONVECTION IN THE SOLAR CONVECTION ZONE. Yoshimura, Hirokazu (Tokyo Univ.). Astrophys. J.; 178: No. 3, 863-86(15 Dec 1972).

The very large-scale nonaxisymmetric convection in the solar convection zone, called here the global convection, has been conceived to explain the solar equatorial acceleration, the clustering in longitudes of magnetic activities, and the proper motions of sunspots. The magnetohydrodynamics of the convection is examined in the framework of a slowly rotating spherical geometry, and the dynamo action is shown to be operated by the global convection when modified by rotation in such a way as to regenerate and reverse the poloidal general magnetic field in the middle layer in the solar convection zone. The global convection driven by the convective instability, in this way, is the basic driving power of both the solar differential rotation and the cyclic magnetic activities of the Sun, i.e., the solar cycle. (auth)

10259 MAGNESIUM II DOUBLET PROFILES OF CHROMOSPHERIC INHOMOGENEITIES AT THE CENTER OF THE SOLAR DISK. Lemaire, P.; Skumanich, A. (CNRS, Verrieres le Buisson, France). Astron. Astrophys.; 22: No. 1, 61-8(Jan 1973).

An analysis of a balloon spectrum of the Sun obtained on June 24, 1970, with 7" angular resolution and 25 mÅ spectral resolution respectively is presented. Average cell, network, and plages profiles near the center of the solar disk are identified and compared with profiles computed on the basis of recent chromospheric models. (auth)

10260 LANDAU DAMPING OF TYPE III SOLAR RADIO BURSTS. Harvey, C. C.; Aubier, M. G. (Observatoire, Meudon, France). Astron. Astrophys.; 22: No. 1, 1-8(Jan 1973).

The propagation of a plasma wave in an inhomogeneous convecting solar wind plasma is studied by means of ray theory. The effect of the solar wind convection is found to be relatively unimportant, whereas the radial density gradient is shown to cause the phase velocity of the plasma wave to decrease, thus increasing the Landau damping. Assuming the plasma hypothesis for the generation of Type III solar radio bursts, the observable effects of the damping are investigated. Using electron temperature and spatial density distributions thought to be appropriate for the solar wind, together with a Maxwellian velocity distribution, it is found that the effect of Landau damping is to cause a relatively abrupt cut-off of the Type III emission. This cut-off occurs after a time comparable with the observed e-folding time at frequencies for which collision damping is unable to explain the observed decay. The possible modification of the high energy "wing" of the velocity distribution is investigated, and a model for the decay of Type III radio bursts is proposed. (auth)

10261 FAST POLARIZED PULSES IN DECAMETER-WAVE RADIATION FROM THE SUN. Barrow, C. H.; Saunders, H. (Univ. of the West Indies, Kingston, Jamaica). Astrophys. Lett.; 12: No. 4, 211-14(Dec 1972).

Solar radio bursts were observed at fixed frequencies close to 18 MHz (left- and right-hand polarization components with an adjacent frequency total-power channel) and 22 MHz (total-power). Fast narrow-band pulses may appear superimposed on some Type III bursts particularly at the beginning and the end of the main burst. Typical durations were in the range 5 to 40 msec with bandwidths less than 150 kHz. Many of the pulses were circularly polarized; consecutive pulses within a sequence may show rapid polarization changes and reversals. The pulses appeared to be similar, in some respects, to those which occur in the decametric emission from Jupiter. (auth)

10262 RADIO TRACKING OF SOLAR ENERGETIC PARTICLES THROUGH INTERPLANETARY SPACE. Fainberg, J.; Evans, L. G.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, MD). Science; 178: No. 4062, 743-5(17 Nov 1972).

Energetic particles ejected from the Sun generate radio waves as they travel out through the interplanetary medium. Satellite observations of this emission at long radio wavelengths provide a means of investigating properties of the interplanetary medium, including the gross magnetic field configuration over distances of 1 astronomical unit. Results of such observations are illustrated. (auth)

10263 NEW CLASSIFICATIONS OF HIGHLY IONIZED Ni, Co, Cr, V, AND ISOELECTRONIC SPECTRA. Fawcett, B. C.

(Culham Lab., Abingdon, Eng.); Cowan, R. D.; Hayes, R. W. J. Phys., B (London); 5: No. 11, 2143-51(Nov 1972).

The far ultraviolet spectra of the highly ionized solar-abundant element nickel is analysed on the basis of new observations of laser produced plasmas. The transitions involved are mainly between principal quantum numbers 3 and 4 and their spectra are now observed and classified in isoelectronic elements in the period between nickel and scandium with the aid of atomic self-consistent field calculations. Recent solar iron identifications are supported and the data provide information about configurations which can account for solar forbidden lines. (auth)

10264 ABSOLUTE SCALE FOR Si I g f-VALUES FROM WALL-STABILIZED ARC MEASUREMENTS. Schulz-Gulde, E. (Westinghouse Research Labs., Pittsburgh). Astron. Astrophys.; 21: No. 2, 313-14(Nov 1972).

A wall-stabilized arc was operated at currents between 40 and 60 A in an atmosphere consisting of about 65% argon, 35% silicon tetrafluoride gas, and a trace of hydrogen. From photoelectric measurements of the emission coefficients of the Si I 5949 Å and Si II 5979 Å lines and the electron density for temperatures ranging from 8500 to 10000°K, a value of gf = 0.051 ± 0.013 was derived for the Si I 5949 Å line assuming an f-value of 0.25 for the Si II 5979 Å line and also assuming a Saha relationship between neutral and ionized silicon atoms. The result is in agreement with previous arc measurements. (auth)

10265 AZIMUTHAL STRUCTURE IN THE SOLAR WIND. Urch, I. H. (Monash Univ., Clayton, Australia). Cosmic Electrodyn.; 3: No. 3, 316-29(Oct 1972).

The magnetohydrodynamic equations that describe an azimuthally dependent solar wind near the equatorial plane are obtained in a simplified form. It is shown how this system of equations can be solved by a perturbation method when the temperature, electron density, and magnetic-field strength at the base of the corona, depend upon solar longitude. Some solutions for the solar-wind flow resulting from several simple coronal configurations are presented. In particular the mean azimuthal velocity of the solar wind has been calculated and, in the cases studied, the interaction between fast and slow streams does not increase the mean azimuthal velocity as has been found by Sakurai (1971). (auth)

10266 SOLAR SPOON. Dilke, F. W. W.; Gough, D. O. (Cambridge Univ., Eng.). Nature (London); 240: No. 5379, 262-4; 293-4(1 Dec 1972).

It is stated that overstability causes the Sun's core to mix every few hundred million years. This induces geological ice ages and temporarily depresses the solar neutrino flux. (auth)

10267 ORBITAL ECCENTRICITY OF MERCURY AND THE ORIGIN OF THE MOON. Cameron, A. G. W. (Yeshiva Univ., New York). Nature (London); 240: No. 5379, 299-300(1 Dec 1972).

Arguments are advanced that the natural place for the formation of the Moon in the solar system is inside the orbit of Mercury, through planetary accumulation from the condensed material to be found there. These also explain the anomalous large eccentricity of the orbit of Mercury. The temperature gradient in the primitive solar nebula was probably steep enough for the orbital radii at which the Moon and Mercury were formed to differ by a much smaller relative amount than do the orbits of other neighbouring plants within the solar system. Gravitational perturbations of the orbits of the two bodies would probably accumulate until a close approach took place, at which a very large change in the elements of the Moon's orbit would become possible, and if the modified orbit of the Moon were sufficiently great to allow it to approach the Earth then gravitational capture of the Moon by the Earth would become possible. Chemical considerations are discussed, and it is stated that the chemical evidence pointing to the formation of the Moon inside the orbit of Mercury is compatible with the dynamical requirement that the transformation of an initial circular orbit of Mercury into the present relative large eccentric orbit should provide enough energy to transform the orbit of the Moon in such a way that the Moon crosses the Earth's orbit. As the lunar exploration programme has progressed there has been an increasing tendency to regard the Moon as a planetary body in its own right, and the foregoing arguments seem to justify this. (UK)

10268 KINEMATICAL BEHAVIOUR OF THE PLASMA TAIL OF COMET TAGO-SATO-KOSAKA 1969 IX. Jockers, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Luest, Rhea; Nowak, Th. Astron. Astrophys.; 21: No. 2, 199-207(Nov 1972).

20 pictures of Comet Tago-Sato-Kosaka, taken on 4 days between January 5 and 12, 1970 with the Hamburg Schmidt-telescope of Boyden Observatory, and 4 exposures made with the Curtis Schmidt telescope at Cerro Tololo (Chile) were used for an analysis of the kinematical behavior of the tail material. The aberration angles between the tail and the comet–Sun line were brought into connection with the solar wind parameters taken from Satellite observations and geophysical data. (W.D.M.)

Galaxies

Refer also to abstracts 10206, 10210, 10218, and 10707.

10269 MASS SPECTRUM OF INTERSTELLAR CLOUDS AND THE ASSUMPTION OF TOTAL COALESCENCE. Taff, L. G.; Savedoff, M. P. (Univ. of Rochester, NY). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 89-97(1972).

Some modifications of the statistical mechanical model for the formation and disruption of interstellar clouds, originally proposed by Field and Saslaw (Astrophys. J.; 142: 568 (1965)), are investigated. It is concluded that the asymptotic nature of the mass spectrum (i.e., $N(m) \approx m^{-\frac{1}{2}}$), under the assumptions of total coalescence and uniform σv, is independent of the redistribution of the larger clouds into the smaller ones and the time dependence of the problem. Some preliminary results of more detailed model calculations are described. (auth)

10270 TWO COLOR PHOTOGRAPHIC SUPERPOSITION PHOTOMETRY OF LENTICULAR GALAXIES IN THE VIRGO CLUSTER. Benedict, G. F. Evanston, IL; Northwestern Univ. (1972). 213p. University Microfilms Order No. 72-32,378.

Thesis.

The photometric parameters and representations derived and presented in this study include: detailed, mean, reduced, and equivalent luminosity and color index profiles and gradients; integrated magnitudes and colors; concentration indices; effective radii, colors and surface magnitudes; ellipticity and inclination values; and major axis position angles. The galaxies for which this material is presented are NGC 4254, 4267, 4298, 4302, 4313, 4321, 4377, 4379, 4380, 4388, 4419, 4425, 4429, 4435, 4438, 4461, 4503, 4531, 4548, 4550, 4552, 4564, 4567, 4571, 4596, 4608, and 4621. (TSS) (Diss. Abstr. Int., B)

10271 DISTRIBUTION OF NEUTRAL HYDROGEN IN THE PERSEUS ARM. Perry, J. F. W. Rochester, NY; Univ. of Rochester (1972). 134p. University Microfilms Order No. 72-28,786.

Thesis.

A statistical analysis was applied to 21 cm data to derive models of the interstellar gas density distribution in small volumes of spiral arms. After subtracting a smooth background model of the arm, the resulting density fluctuations were statistically represented by superpositions of randomly located, spherical clouds. The expected number of these model clouds per unit volume and their central gas densities were both derived as functions of cloud diameter by a correlation analysis, using a Monte Carlo technique. Many small volumes within four large segments of the Perseus arm and one segment of an interarm feature were analyzed. The resulting cloud distributions are presented, covering diameter ranges of 50 to 1000 pcs, or masses 10^3 to 10^6 $M_\odot$. They varied rapidly between small volumes, but the average distributions over each entire arm segment were remarkably consistent. Often there was a distinct lack of clouds between 50 and 100 pcs diameter in these small volumes. The cloud mass spectrum for large regions, however, in keeping with theoretical predictions, were described by a power law $f(m) \propto m^{-\beta}$, with $\beta = 1.75 \pm 0.15$ for the Perseus arm segments and $\beta = 2.0 \pm 0.15$ for the interarm feature, for cloud masses $10^3 \leq m \leq 10^6$ $M_\odot$. There was a surplus of the smallest clouds on the farther side of three of the arm segments and the interarm feature, suggesting the compression of clouds across the arm predicted by the density wave theory. Attempts to obtain relative distances to the segments were partially successful. Evidence is presented to demonstrate that the interarm feature is indeed separated from the Perseus arm in space and not just in velocity. (Diss. Abstr. Int., B)

10272 RADIAL VELOCITIES IN THE TAIL OF NGC 4676A. Theys, J. C. (Columbia Univ., New York); Spiegel, E. A.; Toomre, Juri. Publ. Astron. Soc. Pac.; 84: No. 502, 851-3(Dec 1972).

A spectrum of the long tail of NGC 4676A shows [O II] λ3727 in emission. The radial velocity measured from one plate varies by about 400 km sec^{-1} along the length of the tail. (auth)

10273 KINEMATICS AND DYNAMICS OF M51. Tully, R. B. College Park, MD; Univ. of Maryland (1972). 192p. University Microfilms Order No. 72-28,917.

Thesis.

A photographic Fabry–Perot interferometer was developed which is pressure regulated, permitting full coverage of a field with a sequence of exposures. Observations of M51 in $H\alpha$ were made on the 84-inch telescope at the Kitt Peak National Observatory. Reductions were handled digitally after scanning the photographic plates with a microdensitometer. $H\alpha$ intensities and velocities were determined at all positions where there was a detectable signal by using a deconvolution technique where, at each point in the field, each interferogram provides one point in an intensity–velocity diagram. Except near the edge of the field, velocities are accurate to ±8 km/s (r.m.s.) and emission measures as low as about 30 cm^{-5} pc (assuming $T = 10^4$ °K) are observed. Most of the general parameters describing the vantage point with respect to M51 determined in this investigation were in reasonable agreement with values determined in earlier studies. However, it was convincingly shown that the galaxy is considerably more face-on than it had previously been supposed. (TSS) (Diss. Abstr. Int., B)

10274 ENERGY DISTRIBUTION OF NGC 1068 AND OF OTHER STELLAR SYSTEMS. Schild, R. R. (Smithsonian Astrophysical Observatory, Cambridge, MA). Astrophys. J.; 178: No. 3, 617-21(15 Dec 1972).

The energy distribution of the nonnuclear portions of Seyfert galaxy NGC 1068 is compared with those of M81 and M51; a good correspondence between stellar population and form type on the Morgan system is found, in contrast to a recently noted discrepancy in the Hubble system. Energy distributions for NGC 1068, M3, M67, M87, M11, and NGC 188 are intercompared in a further discussion of the stellar population of the nonnuclear portion of NGC 1068. An unexpected depression in the ultraviolet continuum of M81 relative to M87 is noted. Curvature of the NGC 1068 continuum appears to impose an upper limit of $E_{B-V} = 0.04$ on the reddening of NGC 1068. (auth)

10275 GALACTIC BRIDGES AND TAILS. Toomre, Alar (Massachusetts Inst. of Tech., Cambridge); Toomre, Juri. Astrophys. J.; 178: No. 3, 623-66(15 Dec 1972).

It is argued that the bridges and tails seen in some multiple galaxies are just tidal relics of close encounters. These consequences of the brief but violent tidal forces are studied in a deliberately simple-minded fashion: Each encounter is considered to involve only two galaxies and to be roughly parabolic; each galaxy is idealized as just a disk of noninteracting test particles which initially orbit a central mass point. As shown, the two-sided distortions provoked by gravity alone in such circumstances can indeed evolve kinematically into some remarkably narrow and elongated features: (i) After a relatively direct passage of a small companion, the outer portions of the primary disk often deform both into a near-side spiral arm or "bridge" extending toward this satellite, and into a far-side "counterarm." (ii) A similar encounter with an equal or more massive partner results typically in a long and curving "tail" of escaping debris from the far side of the victim disk, and in an avalanche of near-side particles, most of which are captured by the satellite. Besides extensive pictorial surveys of such tidal damage, reconstructions of the orbits and outer shapes of four specific interacting pairs are offered: Arp 295, M51 + NGC 5195, NGC 4676, and NGC 4038/9. Also discussed are some closely related issues of eccentric bound orbits, orbital decay, accretion, and forced spiral waves. (auth)

10276 STUDY OF THE UNIDENTIFIED INTERSTELLAR DIFFUSE FEATURES. Wu, C. C. (Univ. of Wisconsin, Madison). Astrophys. J.; 178: No. 3, 681-99(15 Dec 1972).

The interstellar diffuse lines λλ5780, 5797 were observed in 66 stars using the Washburn Observatory echelle spectrograph coupled with an image tube. At a resolution of 0.17 Å, the profiles of these diffuse lines were asymmetric and steeper to the blue. There was also a broad, shallow feature shortward of λ5780. The FWHM of λλ5780 and 5797 were respectively 2.7 Å and 1.1 Å. Equivalent widths of λλ5780, 5797 were measured at a resolution of 0.26 Å, and they presented a very tight correlation. It was very likely that these two diffuse lines were carried by the same agent. The correlation between the equivalent width of λ5780, EW(λ5780), and E(B – V) was good for normal field stars. But there was a systematic weakening of λ5780 in the spectra of Be stars, and the reverse was true for stars in the Scorpius–Ophiuchus region. Excluding Be stars, a least-squares fit gave EW(λ5780) = 0.75 E(B – V) Å mag^{-1}. The investigation proposes that λλ5780, 5797 are produced by the pure electronic transitions of the impurity centers in solid grains, with the broad, shallow absorption feature shortward of λ5780 as the absorption sideband associated with the parent pure electronic line. Also, evidences are presented to support the idea that the diffuse band λ4430 may be produced by the preionization of H^-. (auth)

10277 ORIENTATION OF GALAXIES AND THE LOCAL SUPERCLUSTER. Reinhardt, M.; Roberts, M. S. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astrophys. Lett.; 12: No. 4, 201-6(Dec 1972).

The indication that the flattening of a system of galaxies is correlated with the flattening of its constituent galaxies is tested for the Local Supercluster. Two independent sets of data are used. Both sets yield a positive, but modest, correlation that is suggestive of a true physical relation between the orientation of the angular momentum vector of member galaxies and the flattening of the Local Supercluster. (auth)

10278 DISTRIBUTION OF NEUTRAL HYDROGEN AND THE VELOCITY FIELD OF THE GALAXY NGC 3109. Huchtmeier, W. (Observatoire, Meudon, France). Astron. Astrophys.; 22: No. 1, 27-31(Jan 1973).

The irregular-type galaxy NGC 3109 was observed in the 21 cm hydrogen line with the Nancay radio telescope. The H I content was found to be 2.2×10^9 $M_\odot$, or 20% of the total mass of 1.1×10^{10} $M_\odot$. The H I had a flat-topped distribution, being reasonably well represented by a gaussian function. It had a greater extent to the south-west than in other directions. There is a low-density component of H I in the outer regions. Parameters of the H I distribution and the rotation curve were deduced by a model-fitting procedure. There are significant departures from circular motion outside a distance of 20′arc. A value of 10 km/s for the velocity dispersion was found all over the galaxy. (auth)

10279 MEASUREMENTS OF THE ELECTRON TEMPERATURES IN M42 FROM THE PROFILES OF Hα, [N II], Hβ, AND [O III]. Dopita, M. A.; Gibbons, A. H.; Meaburn, J. (Univ. of Manchester, Eng.). Astron. Astrophys.; 22: No. 1, 33-9(Jan 1973).

Two, single-etalon, pressure-scanned Fabry–Perot monochromators were used to obtain the profiles of the Hα, [N II], Hβ, and [O III] lines from many positions across M42 (the Orion Nebula). The electron temperatures predicted from the profiles of the Hα and [N II] lines from each position were critically compared to the temperatures from the corresponding profiles of the Hβ and [O III] lines. This was performed to an unprecedented accuracy because of the high signal to noise ratios that were achieved, the high wavelength resolutions and the use of a rigorous numerical-reduction procedure. The conclusion confirmed previous doubts about the validity of the method using the Hα and [N II] profiles for the Orion Nebula and suggested that using the Hβ and [O III] profiles, while not ideal, gives far more realistic results. (auth)

10280 TIDAL INTERACTION OF GALAXIES. Eneev, T. M.; Kozlov, N. N.; Sunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Astron. Astrophys.; 22: No. 1, 41-60(Jan 1973).

When a massive body closely passes a galaxy, there appear specific tidal effects: spiral structure, considerable deviations from the plane of the disk, distortions of the velocity field of the matter, gas falling onto the galactic plane. A qualitative analysis and numerical calculations allow one to determine the main effects associated with the passage of a massive body in a number of characteristic hyperbolic orbits with respect to the galaxy, i.e., perpendicular to its plane, over the plane, and in the plane both in a forward and backward direction of the galaxy rotation. The behavior of 800 to 2000 noninteracting point satellites initially travelling in circular keplerian orbits around central regions of the galaxy and perturbed by the close passage of a massive body is analyzed. (auth)

10281 GALACTIC STRUCTURE FROM OBSERVATIONS OF INTERSTELLAR CALCIUM LINES. I. ANALYSIS OF THE RADIAL VELOCITIES. Chu-Kit, M. (Observatoire, Marseille). Astron. Astrophys.; 22: No. 1, 69-74(Jan 1973). (In French).

As part of a galactic survey the distribution and kinematics of interstellar calcium were investigated from $l = 285°$, through the galactic center to $l = 29°$. One hundred twenty-two radial velocities of interstellar calcium lines were measured in 68 O–B stars with a dispersion of 12.3 Å mm^{-1} at La Silla Observatory. The kinematical distances were calculated from Schmidt's model. The data from interstellar calcium and O–B stars showed two spiral arms and a possible third one. In the Carina region the residual velocities were not significant. In the longitude range $l = 304$ to $344°$ the radial velocities of interstellar calcium showed 2 maxima, and two arms were observed as clearly separated as the well known Perseus arm and the local arm. In addition, 8 radial velocities were found ranging from –70 to –97 kms^{-1}. Near $l = 0°$, a component at –26 kms^{-1} was seen in a distant star. This may be an expansion feature at a distance of about 4.5 kpc. In the longitude range $l = 0 – 29°$ the Sagittarius spiral arm was found. The extension of the Norma–Centaurus arm in this

region was attempted. The Carina–Sagittarius arm was seen from $l = 285°$ to $l = 29°$. (auth)

10282 GALACTIC DIFFERENTIAL ROTATION DERIVED FROM THE RADIAL VELOCITIES OF SOME POPULATION I OBJECTS. Creze, M. (Observatoire, Paris). Astron. Astrophys.; 22: No. 1, 85-9(Jan 1973).

Solutions for Oort's constant A of galactic differential rotation and for the components of the solar motion were derived from the radial velocities of three population I samples. (Population I Cepheids, H II regions, open clusters). The V_0 components of the solar motion with respect to the samples were larger than the ones which can be derived from the asymmetrical drift relation to their low velocity dispersion. Moreover, separate solutions from young and old open clusters showed that the former ones, which have the smallest velocity dispersions, give a V_0 component greater than 20 km s^{-1}. This phenomenon may be explained by the existence of a spiral density wave which should be more strongly felt for smaller velocity dispersions. After correction of the bias resulting from the random errors of the distance moduli, A was found to be at least 16 ± 0.5 km s^{-1} kpc^{-1}, provided that the existence of different absorption laws inside and outside the spiral arms (Creze, 1972) is confirmed. Thus, the conventional value A = 15 could be a little underestimated and hence the distance of the galactic center could be no larger than 9 kpc. (auth)

10283 NEUTRAL HYDROGEN SURVEY OF THE GALAXY M33. II. DISTRIBUTION AND KINEMATICS OF THE NEUTRAL HYDROGEN. Huchtmeier, W. (Observatoire, Meudon, France). Astron. Astrophys.; 22: No. 1, 91-109(Jan 1973).

The nearby Sc-type galaxy NGC 598 (M33) has been observed within the 21-cm line of neutral atomic hydrogen with the 200-m Nancay telescope. The distribution of neutral hydrogen and the kinematical properties of the galaxy were derived. The assumed distance was 720 kpc, and the mass of H I was found to be 1.8×10^9 $M_\odot$ being 4.5% of the total mass of 4.0×10^{10} $M_\odot$. H I could be represented by a large double ring structure overlaid on a uniform disk with a central density depression of 35%. A more detailed structure could be derived by using a model-fitting procedure. (W.D.M.)

10284 APERTURE SYNTHESIS STUDY OF NEUTRAL HYDROGEN IN THE GALAXIES NGC 6946 AND IC 342. Rogstad, D. H. (California Inst. of Tech., Pasadena); Shostak, G. S.; Rots, A. H. Astron. Astrophys.; 22: No. 1, 111-19(Jan 1973).

Synthesis observations of neutral hydrogen emission in the two spiral galaxies NGC 6946 and IC 342 are presented. The velocity resolution is 21 km/s and the angular resolution is 2 and 4 min of arc for NGC 6946 and IC 342, respectively. Results are presented in the form of contour maps of the integral and mean velocity of the H I profile at each position in the galaxy, as well as a line profile for each galaxy as a whole. Both galaxies evidence a central depression in their H I distributions. The rotation curves have steep central gradients with rather constant velocities once the maximal velocity is reached. The H I mass for NGC 6946 is 21×10^9 $M_\odot$ and for IC 342 is 15×10^9 $M_\odot$, assuming distances of 10.1 and 4.5 Mpc, respectively. Other properties are summarized. (auth)

10285 HIGH-VELOCITY CLOUDS AND NORMAL GALACTIC STRUCTURE. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, WV). Astron. Astrophys.; 22: No. 1, 139-51(Jan 1973).

Most of the high-velocity clouds of neutral hydrogen which lie at intermediate and high galactic latitudes, as well as the highest velocity clouds which lie near the plane are probably part of distant spiral arms. These arms arch to large distances from the plane and extend many kilo-parsecs in the z direction. Since the arms are extremely nonuniform and nonplanar they have not here-to-fore been recognized in galactic plane surveys. In addition, these arms show considerable noncircular motions. (auth)

10286 NOTE ON VERSCHUUR'S ARTICLE ON HIGH-VELOCITY CLOUDS AND NORMAL GALACTIC STRUCTURE. Hulsbosch, A. N. M.; Oort, J. H. (Leiden Observatory). Astron. Astrophys.; 22: No. 1, 153-4(Jan 1973).

Verschuur's model which explains most of the high-velocity clouds as being parts of distant spiral arms is discussed. It is argued that, at least for the lower latitudes, this model deserves attention but that at the high latitudes, which to us seem the crucial places for a study of the nature of these clouds, it encounters great difficulties, as noted also by Verschuur. For explaining the high-velocity clouds at high latitudes the model in which an intergalactic wind is supposed to supply momentum to neutral hydrogen complexes in the outlying parts of spiral arms provides a more satisfactory interpretation. (auth)

10287 CARBON STARS IN THE NORTHERN MILKY WAY. Hardorp, J. (State Univ. of New York, Stony Brook); Luebeck, K.; Stephenson, C. B. Astron. Astrophys.; 22: No. 1, 129-31(Jan 1973).

Fifty-nine carbon stars, 4 of which are new, were found in the areas I, III, and V of the catalog "Luminous Stars in the Northern Milky Way" and were subdivided into classes R and N by means of the 4350 Å spectral discontinuity. Equatorial coordinates of about 1" precision were determined, and for many stars approximate photographic magnitudes were also derived. (auth)

10288 GALACTIC ROTATION AND SECOND ORDER TERMS. Taff, L. G.; Littleton, J. E. (Univ. of Rochester, NY). Astron. Astrophys.; 21: No. 3, 443-6(Dec 1972).

An analysis of the motion of objects in the Galaxy to second order in r/R_0 yields a mathematically complete set of equations for the galactic rotation parameters. This second order analysis was applied to the galactic clusters in the catalogue of Hagen (1970). A reexamination of Humphreys' (1970) work on galactic rotation using supergiants shows a bias in her study (i.e., the a priori assumption that $R_0 = 10$ kpc) which is removed. After analyzing the supergiants in the same manner as the galactic clusters it is found that her first order constant, Oort's A, is inconsistent with the value of A obtained from the galactic clusters and other classes of objects. The considerable scatter in the second order results for the supergiants and the clusters, in addition to the large probable errors, leads to the conclusion that there is not yet sufficient data for a definitive calculation of these second order constants. (auth)

10289 SEARCHES FOR MICROWAVE SPECTRAL LINE RADIATION FROM SOME MOLECULES IN THE INTERSTELLAR MEDIUM. Cato, T.; Ellder, J.; Hoeglund, B.; (and others) (Chalmers Univ. of Tech., Onsala, Sweden). Astron. Astrophys.; 21: No. 3, 435-40(Dec 1972).

The Onsala 25.6 m radio telescope equipped with travelling wave maser radiometers at the appropriate frequencies has been used in searches for absorption or emission lines from a number of different organic and inorganic molecules in the direction of several radio sources. The molecules include OH (the $^2\Pi_{\frac{3}{2}}$, $J = \frac{3}{2}$, $v = 1$ vibrational state; and the second and third harmonics of some ground state transitions), CH (the ground state $^2\Pi_{\frac{1}{2}}$, $J = \frac{1}{2}$, and the $^2\Pi_{\frac{3}{2}}$, $J = \frac{3}{2}$ excited state), SO_2, HCN, H_2CS, NH_2CHO, and CH_3CHO. All searches gave negative results, with possible exception for H_2CS. Details of the observations are tabulated. (auth)

10290 KINEMATICS OF A SAMPLE OF VERY RED STARS AT THE SOUTH GALACTIC POLE. Gliese, W. (Astronomisches Rechen-Institut, Heidelberg). Astron. Astrophys.; 21: No. 3, 431-3(Dec 1972).

From the proper motion distribution of 75 very red stars near the south galactic pole a mean group parallax of about 0.04" is derived. The objects either form a cloud in that region or they are representative of the star density of red dwarfs in the solar neighborhood. This density is considerably larger than was previously thought. The latter conclusion agrees with similar observations near the north galactic pole. (auth)

10291 REMARKS ON THE RADIAL VELOCITIES OF GALAXIES IN THE VIRGO CLUSTER. Tammann, G. A. (Univ., Basel). Astron. Astrophys.; 21: No. 3, 355-9(Dec 1972).

Redshifts for 122 probable members of the Virgo Cluster are compiled and, where possible, corrected for systematic errors. The mean radial velocity of the cluster relative to the galactic center is determined to be 1141 ± 60 km s^{-1} and the velocity dispersion to be $\sigma = 666$ km s^{-1}. There is no significant radial velocity difference between elliptical-lenticular galaxies and spiral galaxies. The velocity distribution of elliptical-lenticular galaxies as well as of spiral galaxies can reasonably well be approximated by a gaussian distribution. (auth)

10292 EXTENSION OF THE OBJECTIVE-PRISM TECHNIQUES TO THE SEARCH OF FAINT STARS IN THE LMC. Martin, N.; Rebeirot, E. (Observatoire, Marseille). Astron. Astrophys.; 21: No. 3, 329-35(Dec 1972). (In French).

The present objective-prism technique has been adapted to solve two problems. The first is to detect LMC OB stars of fourteenth magnitude. The second is to have a greater number of radial velocities especially in this very crowded region which has far too many overlappings. The first problem was tackled by adding an interferential filter which cuts the night sky light as well as the part of the spectrum which is before Hδ. It allows one to increase considerably the exposure time. For the second, instead of widening the spectra of two hundred and fifty microns, they were widened one hundred and fifty microns which gave a

gain of 0.6 magnitude for the same exposure time. Loss of accuracy was avoided by adjusting the two prisms as to have two spectra side by side. (auth)

10293 RADIO EMISSION OF NGC 4258 AND THE POSSIBLE ORIGIN OF SPIRAL STRUCTURE. van der Kruit, P. C. (Observatory, Leiden); Oort, J. H.; Mathewson, D. S. Astron. Astrophys.; 21: No. 2, 169-84(Nov 1972).

The radio structure of the spiral galaxy NGC 4258 was investigated with a beam of 24″ × 32″ at 1415 MHz. The radio structure showed two curved "ridges" of considerable intensity which differ in position, shape, and continuity from the optical arms. They run straight across these arms and are remarkably smooth over their entire length. These radio arms, which lie probably in the same plane as the optical arms, are practically straight between 5 and 15 kpc from the center. Inside 5 kpc they curve around and join the major axis of the galaxy. In this part they coincide precisely with the remarkable filamentary H_α-arms discovered on interference-filter photographs by Courtès and Cruvellier in 1961. (W.D.M.)

10294 21-cm NEUTRAL HYDROGEN LINE STUDY OF EARLY TYPE GALAXIES. Balkowski, C.; Bottinelli, L.; Gouguenheim, L.; Heidmann, J. (Observatoire, Meudon, France). Astron. Astrophys.; 21: No. 2, 303-10(Nov 1972).

Eighteen more lenticular to Sab galaxies (including 8 upper limits), were observed with the Nançay radio telescope in the 21-cm line of neutral hydrogen. Adding these data to those previously obtained at Nançay for 15 other galaxies of these types, it is shown that the neutral hydrogen content of early type galaxies is relatively large and that the mass to light ratio is practically constant from lenticular to irregular galaxies. The hydrogen diameter was determined for three of them, including the peculiar galaxy NGC 1808. Lenticulars have an H I component with mass and diameter comparable to the spirals and the fact that they have no arms should be relevant to the theories of spiral structure. (auth)

10295 DISTRIBUTION OF EARLY TYPE STARS IN CIRCINUS (l = 316.9°; 327.9°; b = 2.8°; −5.9°) ALONG THE GALACTIC EQUATOR. Oyen, F. (Katholieke Univ., Louvain, Belgium). Astron. Astrophys.; 21: No. 2, 315-16(Nov 1972).

In four regions of Circinus 249 OB-stars were selected. For one of these regions the density distribution as a function of the distance was drafted based upon photographic magnitudes of 59 OB-stars. It points to the existence of a spiral arm. (auth)

10296 REMARKS ON THE COMPARISON BETWEEN THE SANDULEAK AND THE FEHRENBACH–DUFLOT CATALOGS OF LMC MEMBER STARS. Fehrenbach, Ch.; Duflot, M. (Observatoire, Marseille). Astron. Astrophys.; 21: No. 2, 321-6 (Nov 1972). (In French).

Some thirty stars for which the spectral classification gives a luminosity class between giants and supergiants are, actually, LMC members of absolute magnitude −6. Their spectra and colors set problems but no difference can be made between them and proven LMC members of the same magnitude. (auth)

Cosmology

Refer also to abstracts 10698 and 10707.

10297 HYPOTHESIS, UNIFYING THE STRUCTURE AND THE ENTROPY OF THE UNIVERSE. Zeldovich, Ya. B. (Inst. of Applied Mathematics, Moscow). Mon. Notic. Roy. Astron. Soc.; 160: No. 1, 1P-3P(1972).

A hypothesis about the averaged initial state and its perturbations is put forward, describing the entropy of the hot Universe (due to damping of short waves) and its structure (clusters of galaxies due to long-wave perturbations). (auth)

10298 COSMOLOGY AND INFORMATION. Gudehus, D. H. (Univ. of California, Los Angeles). Publ. Astron. Soc. Pac.; 84: No. 502, 818-22(Dec 1972).

The dependence of information derived from a photographic plate on the expansion of the Universe is discussed and the accuracy with which the deceleration parameter, q_0, can be obtained from the redshift–magnitude relation is estimated for various telescopes. (auth)

10299 ENERGY AND ANGULAR MOMENTUM FLOW INTO A BLACK HOLE. Hawking, S. W. (Cambridge Univ., Eng.); Hartle, J. B. Commun. Math. Phys.; 27: No. 4, 283-90(1972).

The area of the event horizon round a rotating black hole will increase in the presence of a nonaxisymmetric or time dependent perturbation. If the perturbation is a matter field, the area increase is related to the fluxes of energy and of angular momentum into the black hole in such a way as to maintain the formula for the area in the Kerr solution. For purely gravitational perturbations one cannot define angular momentum locally but one can use the area increase and the expression for area in terms of mass and angular momentum to calculate the slowing down of a black hole caused by a nonaxisymmetric distribution of matter at a distance. It seems that the coupling between the rotation of a black hole and the orbit of a particle going round it can be significant if the angular momentum of the black hole is close to its maximum possible value and if the angular velocity of the particle is nearly equal to that of the black hole. (auth)

10300 GRAVITATION, STRONG INTERACTIONS, AND THE CREATION OF THE UNIVERSE. Sarfatt, J. (Birkbeck Coll., London). Nature (London) Phys. Sci.; 240: No. 101, 101-2 (4 Dec 1972).

The hypothesis is discussed that strong interactions are gravitational in origin, and that unitary symmetry is a consequence of the equivalence principle of general relativity. This hypothesis is a natural extension of the Misner–Wheeler "geometrodynamics" concept, which gives a world view that describes all physics in terms of space–time curvature and multiply connected spacelike hypersurfaces (Ann. Phys. 2: 525 (1959)). Quantum geometrodynamics for strong interactions assumes that the fundamental building block for hadronic matter is the parton, which is identified with a massive quantum blackhole of bare mass 10^{-5} g and radius 10^{-33} cm. Mesons and baryons are built from bare partons in a two-stage process, involving stable quark states, antipartons, gravitons, photons and neutrinos, and the fusion of bare partons is a cataclysmic event that occurred at the creation of the Universe in the primordial "big bang"; it might be conjectured that this process is providing the energy source for quasars. SU(3) strong interaction symmetry is a consequence of the universality of gravitation and it is shown how gravitation can act superstrongly on the primordial level of bare partons or quantum blackholes, and also that nuclear forces represent an indirect collective gravitational effect. Models of hadronic matter are briefly discussed, with particular reference to Tryon's "spinning loop" model (Phys. Rev. Lett. 28: 1605 (1972)). (UK)

10301 NEW WAY TO OBSERVE GRAVITATIONAL WAVES. Ceapa, A. Nature (London) Phys. Sci.; 240: No. 101, 102-3 (4 Dec 1972).

A new interpretation of the nature of gravitational waves of high frequency and intensity is given, together with a new method of finding evidence for them. It is possible to reverse the polarity of a fermionic system rapidly by electromagnetic methods, and such a spin reversal changes the internal mass–energy structure of particles and gives rise to gravitational waves. Difficulties arise, however, in interpretation, since it is not known how to incorporate quantum effects into a gravitational theory, and it is only in the linear form of Einsteins' theory of gravity that it is known how to include time changes in inertial moments as sources for the equations of gravitational waves. A source description applicable both to quantum theory and to the complete form of general relativity is, however, given. It is possible to generate gravitational waves by the total energy changes of a macroscopic as well as a microscopic system. In the microscopic case time changes in the system energy, giving rise to gravitational waves, can be caused by spin polarization change. These waves are a consequence of the change in the internal structure of the space–time of the particles as well as between them. Gravitational waves can also be detected by the polarization effect on the constituent particles of a receiver totally shielded from electromagnetic fields. The effect might generate electromagnetic fields and new gravitational waves, or destroy the matter. In this connection the use of superconducting metals is suggested. Suitable experiments are technically feasible, and should provide not only a new technique for observing classical general relativity effects, but also an insight into quantized gravity. (UK)

10302 LOWERING A ROPE INTO A BLACK HOLE. Gibbons, G. W. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 240: No. 100, 77(27 Nov 1972).

The idea is discussed of what happens on slowly lowering a particle at the end of a rope into a black hole, or rather its ergosphere, and letting the gravitational field do work on apparatus at the upper end of the rope. In effect this might provide an excellent form of waste disposal that could in principle convert waste heat and material refuse into useful energy. If the particle is lowered into the ergosphere it should be possible to extract a total energy of 100% of its rest mass. Stresses in the rope are calculated for a general stationary space–time, and

a simple formula is derived relating the tension at any point of the rope to the gravitational potential, and this is used to show firstly that no matter how strong the rope it must break before the particle reaches the ergosphere, and secondly if the energy (including rest mass energy) per unit proper length of the rope is independent of the tension, and the material obeys the weak-energy condition, then no more than 63.212% of the rest mass of the particle can be extracted. (UK)

10303 UNIVERSE AS A BLACK HOLE. Pathria, R. K. (Univ. of Waterloo, Ont.). Nature (London); 240: No. 5379, 298-9(1 Dec 1972).

Since Einstein applied his general theory of relativity to study the structure of the Universe as a whole, cosmologists have wondered if the Universe is geometrically closed or open. Neither theory nor observation has been able to settle this question unambiguously. Several authors have hoped that the Universe may after all be a closed, yet unbounded, system. This would solve many problems regarding the nature and origin of the Universe, and would fit many of the observations of distant sources made at radio, optical, and other wavelengths. Here it is demonstrated that the Universe may not only be a closed structure (as perceived by its inhabitants at the present epoch) but may also be a black hole, confined to a localized region of space which cannot expand without limit. (auth)

Planetary Phenomena

Refer also to abstract 10722.

10304 JOVIAN DECAMETRIC ROTATION PERIOD. Kaiser, M. L.; Alexander, J. K. (Goddard Space Flight Center, Greenbelt, MD). Astrophys. Lett.; 12: No. 4, 215-17(Dec 1972).

A new power-spectrum analysis method was used to determine the Jovian decametric rotation period from nearly 17 yr of observations. The value deduced was 9^h, 55^m, 29.70 ± 0.02^s, in agreement with most recent determinations. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstract 11144.

10305 (AD–743952) POLAR-CAP BIBLIOGRAPHY WITH ABSTRACTS. 1. THE POLAR CAP IONOSPHERE. Brenton, J. G. (Dikewood Corp., Albuquerque, N. Mex.). 15 Mar 1972. Contract F19628-70-C-0212. 196p. (DC-TR-1212-2; AFCRL-72-241). NTIS.

This bibliography was compiled as Volume 1 in a series of bibliographies with abstracts on selected topics in the literature on upper atmospheric phenomena in the inner regions of the polar caps. Although a few references are to papers stemming from investigations during the First Polar Year, in general, the references begin with those on activities during the International Geophysical Year and continue with articles published through the year 1971. (auth)

10306 (AD–744074) OPTICAL EFFECTS OF THE MARCH 1970 GEOPHYSICAL EVENT AT THE AFCRL GEOPOLE OBSERVATORY, THULE AIR BASE, GREENLAND. Silverman, S. M.; Moore, J. G. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 18 Apr 1972. 22p. (AFCRL-72-259; AFCRL-ERP-398). NTIS.

The optical observations from Geopole Observatory, Thule A. B., Greenland, during the March 6–10, 1970 event are discussed. The spectral data were considered in detail for two periods, on March 6 and March 9, preceding and during the PCA. The ratio of the 5577A (O I) and 6300A (O I) emission intensities for several disturbed periods is found to be consistent with excitation somewhat below the normal F-region heights for production of 6300A (O I). Use of optical and riometer data in conjunction indicates a hardening of the input energy spectrum on the 8th with a strong softening on the 9th, in accord with expectations from the moderate character of the PCA. A comparison of luminosity fluctuations at Qanaq and Geopole lead to movements of excitations with velocities of the order of 250 to 300 m/s. Possible flare effects are noted and discussed. (auth)

10307 (AD–744090) POLAR CAP BIBLIOGRAPHY. Brenton, J. G. (Dikewood Corp., Albuquerque, N. Mex.). 8 Sep 1971. Contract F19628-70-C-0212. 393p. (DC-TR-1212-1; AFCRL-72-239). NTIS.

This bibliography was compiled with the objective of providing information on the nature and extent of past and current polar-cap research in the field of upper-atmosphere phenomenology. The bibliography lists references to the literature on upper-atmospheric phenomena in the polar caps grouped by subject with introductory summaries. The introductory summaries generally cover briefly the contents of the literature referenced for each subject. Sixty-eight subjects are covered with a total of 2,211 references in 385 pages, of which 134 pages contain the text of the introductory summaries. The eight major sections bear subject headings as follows: (1) Surveys and Summaries; (2) Atmospheric Structure; (3) Energy Inputs; (4) Energy Outputs; (5) Disturbance Phenomena; (6) Ionosphere; (7) Geophysical Effects Peculiar to Polar Cap Regions; and (8) Instrumentation and Measurement Systems. (auth)

10308 (AD–744470) STRATOSPHERIC–IONOSPHERIC INTERACTION DURING THE MOVEMENT OF A PLANETARY WAVE IN JANUARY 1967. Williams, B. H.; Olsen, R. O.; Kays, M. D. (Army Electronics Command, White Sands Missile Range, N. Mex. Atmospheric Sciences Lab.). Mar 1972. 44p. (ECOM-5428). NTIS.

Examination of meteorological synoptic analyses in the stratosphere and lower mesosphere and f (min) values observed over North America reveals a significant correlation between the passage of a deep planetary wave and increased electron densities in the lower ionosphere. As evidence of this correlation, a series of synoptic analyses were concentrated in the upper stratosphere, along with longitudinal cross sections of zonal winds and temperatures, and profiles of f (min and the zonal, meridional and vertical components of the wind at 40 and 50 km). These calculations show, in general, that the correlation increases with altitude, decreases with an increase in latitude, and that the zonal wind in midlatitudes exhibits the highest correlation. Correlation coefficients between f (min) and planetary magnetic indices, solar sunspot number and solar flux would point to exclusion of extraterrestrial parameters as a source of the observed electron increase. (auth)

10309 (JPRS–57474) IONOSPHERIC RESEARCH IN THE USSR. Misyura, V. A.; Ben'kova, N. P.; (and others). Translated from Ionos. Issled.; No. 20, 85-93; 181-4(1972). 20p. NTIS.

Results were presented of a study of the ionosphere by the method of noncoherent scattering of radio waves and research conducted during the international quiet Sun year. (46 references) (JPRS)

10310 EQUATORIAL SCINTILLATION. Koster, J. R. (Univ. of Ghana, Accra). Planet. Space Sci.; 20: No. 12, 1999-2014(Dec 1972).

Equatorial scintillations have been observed at Legon, Ghana for nearly 20 yr. The occurrence characteristics of the scintillations are reviewed, and the physical characteristics of the electron-density irregularities summarized. A much more comprehensive summary of the seasonal variation of scintillation is given, and it is found to be remarkably similar to the variations in thermospheric temperature. Evidence for the suppression of scintillation during magnetic disturbances is given. Curves for the daily variation of the Faraday rotation angle φ are presented, and their unusual post-sunset behavior is noted. It is suggested that this can be explained in terms of a theory presented by Rishbeth (Planet. Space Sci., 19: 357(1971)), in which the F-region ionization moves with nearly the full velocity of the neutral atmospheric wind at night, after the E-region conductivity has fallen to a relatively low value. This can account for the observed drift velocity of the irregularities. The rapid increase in the post-sunset horizontal velocity of the ionization, together with the observed vertical rise, can account for the variations of φ. It is further suggested that the large gradients in the density and drift velocity of the ionization resulting from the mechanism suggested by Rishbeth give rise to the production of the observed F-region irregularities in electron density that cause equatorial scintillation. (auth)

10311 OBSERVATIONS OF IONOSPHERIC ELECTRON CONTENT AT MEDIUM LATITUDE GEOMAGNETICALLY CONJUGATE STATIONS. Yeh, K. C. (Univ. of Illinois, Urbana). Planet. Space Sci.; 20: No. 12, 2045-50(Dec 1972).

Electron content data recorded at Cold Bay, Alaska and Invercargill, New Zealand were used to study the geomagnetic conjugate effects. The correlation on day-to-day variations at these two stations is found to be negative at extreme magnetic quiet and it then increases to positive values with magnetic activities. When disturbed magnetically, the correlation is +0.73. Evidence is presented to show that, on the first day following the sudden commencement, the afternoon rise and the subsequent pre-sunset fall in electron content is controlled geomagnetically. (auth)

10312 ELECTRON EXCITATION AND AURORAL EMISSION PARAMETERS. Judge, R. J. R. (Univ. of California, La Jolla, San Diego). Planet. Space Sci.; 20: No. 12, 2081-92 (Dec 1972).

Auroral luminosities of the main emission lines in the aurora are calculated for excitation by an isotropic primary electron flux with spectra of the form $J(E) = AE \exp(-E/E_1) + B(E_2)E \exp(-E/E_2)$. The variations of emissions from O and N_2^+ with height are shown, as are the variations of column-integrated intensities and pertinent intensity ratios with the characteristic energy E_2, this leading to a method of estimating the electron spectrum from ground observation. (auth)

10313 ION VELOCITY DISTRIBUTIONS IN THE AURORAL IONOSPHERE. Schunk, R. W., Walker, J. C. G. (Yale Univ., New Haven). Planet. Space Sci.; 20: No. 12, 2175-91(Dec 1972).

For application to studies of the auroral ionosphere the velocity distribution of the ions in a weakly ionized plasma subjected to crossed electric and magnetic fields was calculated. Enough terms were retained in the series expansion of the distribution so that conditions could be determined under which departures from the Maxwellian form become significant and what the nature of these departures is, but precise values of the distribution function cannot be calculated when the departures are large. Departures are negligibly small under conditions appropriate to the auroral ionosphere at low altitudes, where the ion–neutral collision frequency is much larger than the ion cyclotron frequency. At altitudes above about 120 km, however, the magnitude of the departures varies little with altitude. Electric fields greater than 25 mVm^{-1} cause departures from the Maxwellian distribution that are greater than 20% at random velocities equal to or greater than twice the mean thermal speed of the ions. Under almost all conditions it was found that the distribution is

depleted in ions moving parallel to the magnetic field relative to those moving perpendicular, an effect that might be detectable in ionospheric measurements of ion temperature. (auth)

10314 IONOSPHERIC PLASMA FLOW PAST A SEMI-INFINITE CYLINDER. Sheldon, J. W. (Florida International Univ., Miami). Planet. Space Sci.; 20: No. 12, 2193-5(Dec 1972).

The ionospheric flow regime in which the flow velocity is well above the ambient ion thermal velocity, but far below the ambient electron thermal velocity, is considered. The flow is parallel to the axis of a conducting semi-infinite cylinder and is directed toward the end disk. Taylor's heuristic method (Planet. Space Sci., 15: 155(1967)) is employed to obtain the approximate spatial dependence of the electric potential and the ion density and velocity. An expression is obtained from these parameters for the net current to the end disk. (auth)

10315 CORRECTING THE OH CONTRIBUTION IN EMISSION LINE MEASUREMENTS IN THE NIGHT AIRGLOW FILTER PHOTOMETRY. Rao, V. R.; Kulkarni, P. V. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 20: No. 12, 2198-2201(Dec 1972).

From the night airglow observations of OH (7-2) and OH (8-3) bands made at Mt. Abu (24.6°N, 72.7°E geographic) it has been noted that there is high positive correlation in their intensity variations (Rao and Kulkarni, Indian J. Pure Appl. Phys., 9: 644(1971)). Assuming covariation of the other OH-band emissions and also their average emission ratios, it is possible to estimate the contribution of one band "contaminating" the measurement of line emission made by a filter of moderate width from the measurement of another band. In the second method, an attempt is made to estimate the OH contamination from the measurement through two filters centered on the emission line of airglow. (auth)

10316 CHANGES IN THE THERMOSPHERIC MOLECULAR OXYGEN ABUNDANCE INFERRED FROM TWILIGHT 6300 A AIRGLOW. Noxon, J. F.; Johanson, A. E. (Harvard Univ., Cambridge, MA). Planet. Space Sci.; 20: No. 12, 2125-51(Dec 1972).

When the local solar zenith angle, χ_L, is ~105° the 6300-A line is much stronger than expected on the basis of F-region ionic recombination alone. Between 95 and 105° the additional intensity is quantitatively explained by production of $O(^1D)$ from photolysis of O_2 in the Schumann–Runge continuum, ($\lambda\lambda$ 1300 to 1750 A) using current values for solar flux, atmospheric composition, and quenching of $O(^1D)$ by N_2. The Schumann–Runge (SR) component exhibits a large seasonal variation with a maximum in summer. This variation is interpreted as implying a seasonal change in thermospheric O_2 abundance; the change seems largely to reflect a variation in O_2 density at the base of the diffusive regime although some contribution may come from changes in thermospheric temperature structure. Large changes in the SR component exist from day to day and with a 27-day period following a major magnetic storm. The photodissociation source becomes inadequate when $\chi_L = 95°$; at 90° more than half of the intensity comes from still another source that is identified as local photoelectron excitation of O atoms. (auth)

10317 PLANETARY-SCALE FLUCTUATIONS OF PRESSURE IN THE E-LAYER, f-min, AND PRESSURE IN THE STRATOSPHERE. Deland, R. J.; Cavalieri, D. J. (New York Univ., NY). J. Atmos. Terrest. Phys.; 35: No. 1, 125-32(Jan 1973).

Fluctuations of the height of an electron-density isopleth in the E layer, estimated from Aberystwyth ionosonde observations by Brown and Williams (J. Atmos. Terr. Phys.; 33: 1321(1971)), are shown to be well correlated with simultaneous planetary-scale fluctuations of f-min analyzed by Deland and Friedman (J. Atmos. Terr. Phys.; 34: 295(1972)). The magnitudes of wind speed and temperature fluctuations in the lower ionosphere associated with these fluctuations are estimated from the observations. (auth)

10318 DIURNAL VARIATION IN THE E-LAYER IONIZATION. Kouris, S. S.; Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 35: No. 1, 133-9(Jan 1973).

Using f_0E data over a period of 11 years, from 45 ionospheric stations, the value of the diurnal exponent ρ in the expression $(f_0E)^4 = A(\cos\chi)^\rho$ is investigated. Statistical F tests are used to demonstrate the important facts that: (a) the value of ρ does not vary with season; and (b) it does not exhibit any systematic variation with the latitude of the station. (auth)

10319 WORLD MORPHOLOGY OF THE APPLETON E-LAYER SEASONAL ANOMALY. Kouris, S. S.; Muggleton, L. M. (Univ. of Edinburgh). J. Atmos. Terrest. Phys.; 35: No. 1, 141-51(Jan 1973).

The world morphology of the Appleton E-layer seasonal anomaly is investigated, and it is shown that it depends not only on latitude but also on longitude and hemisphere. It is suggested that the anomaly could be the result of seasonal variations in the Sq current system. (auth)

10320 SEASONAL VARIATION OF THE HEIGHT AND THICKNESS OF THE E-REGION. Whitehead, J. D. (Univ. of Queensland, St. Lucia, Australia). J. Atmos. Terrest. Phys.; 35: No. 1, 183-5(Jan 1973).

A model of the E region is compared with measurements. The winter E region is anomalously thin, being only one-half the thickness of the summer E region. It is difficult to account for this. (auth)

10321 INVESTIGATION INTO THE ORIGIN OF AN ELF DISCRETE SIGNAL. Fleming, R. A. (Univ. of Queensland, St. Lucia, Australia). J. Atmos. Terrest. Phys.; 35: No. 1, 187-9(Jan 1973).

A high-intensity geomagnetic disturbance at extremely low frequency received simultaneously at two space stations supports the theory that extra-terrestrial particles, in this case solar protons, contribute to elf signal generation. (auth)

10322 OPTICAL AURORA. Omholt, A. Physics and Chemistry in Space. Volume 4. New York; Springer-Verlag (1971). 210p. $18.40.

The aurora is described and discussed as an optical phenomenon discerned by the naked eye and more sensitive optical detectors. The major phenomena considered are the ejection of plasma from the Sun, the interaction of this plasma with the geomagnetic field, and the injection of fast particles into the Earth's atmosphere. The study involves the detection and interpretation of electromagnetic radiation, approximately in the 1000- to 100,000-Å region, produced through interaction between the auroral particles and the Earth's atmosphere. The chapters by title are: The Occurrence and Cause of Auroras; The Electron Aurora; The Proton Aurora; The Optical Spectrum of Aurora; Physics of the Optical Emissions; Temperature Determinations from Auroral Emissions; Pulsing Aurora; Optical Aurora and Radio Observations; and Auroral X-rays. (400 references) (J.C.W.)

10323 PRODUCTION AND ANALYSIS OF TRANSMISSION IONOGRAMS. Titheridge, J. E.; Heron, M. L. (Univ. of Auckland, N. Z.). Planet. Space Sci.; 20: No. 12, 2029-38(Dec 1972).

A transmission ionogram gives the group delay for radio pulses transmitted vertically through the ionosphere as the radio frequency is varied. These virtual-height curves may also be produced from fixed-frequency observations on orbiting satellites. Analysis of such records can give the thickness of the peak of the ionosphere, a quantity not readily obtained by other techniques. Using the ground reflection trace on top-side ionograms, a rapid two-parameter analysis gives the peak thickness to better than 10%. (auth)

10324 IONOSPHERIC SCALE HEIGHT FROM THE REFRACTION OF SATELLITE SIGNALS. Heron, M. L.; Titheridge, J. E. (Univ. of Auckland, N. Z.). Planet. Space Sci.; 20: No. 12, 2015-28(Dec 1972).

Accurate observations of the elevation angle of arrival of 20-MHz signals from the polar-orbiting satellite Beacon-B for a 20-month period have provided transmission ionograms that may be reduced to give Hp, the scale height at the peak of the ionosphere. Noon seasonal averages of Hp are 1.35 (in winter) to 1.55 (in summer) times greater than the scale height obtained from bottom-side ionograms. A comparison of scale height at the peak with routine measurements of total content and peak electron density indicates that the O^+/H^+ transition level is above 1000 km during the day, but comes down to about 630 km on winter nights. A predawn peak in the overall scale height ($\propto$ total content/peak density) is caused by a lowering of the layer to a region of increased recombination and is magnified in winter by low O^+/H^+ transition levels. After sunrise in winter and equinoxes the overall scale height is less than the scale height at the peak, implying an outwards flux of ionization that lasts for about three hours. The summer evening increase in f_0F2 requires both a cooling and a raising of the layer for its occurrence. (auth)

10325 VERTICAL SOUNDING OF THE POLAR D-REGION. Helms, W. J. (Univ. of Washington, Seattle). Antarct. J. U. S.; 7: No. 5, 166-8(1972).

Vertical sounding of the polar D region shows that the lower ionosphere is mainly affected by precipitation of electrons from the magnetosphere, solar x rays, and occasional large bursts of energetic solar protons. Direct ionization of trace constituents by solar uv radiation appears to be of secondary importance. A

relationship is shown to exist between enhanced solar proton flux and large decreases in average D-region height. Electron-density profiles were obtained from sounder data. Three electron-density profiles were analyzed that were taken during the onset of PCA event, at which time several solar flares were involved. (J.C.W.)

10326 SECULAR VARIATION OF THE STRATOSPHERIC OZONE LAYER OVER MIDDLE EUROPE DURING THE SOLAR CYCLES FROM 1951 TO 1972. Paetzold, H. K.; Piscalar, F.; Zschoerner, H. (Univ., Cologne). Nature (London) Phys. Sci.; 240: No. 101, 106-7(4 Dec 1972).

Observations made with an optical ozone radiosonde are reported that provide further evidence for an earlier suggestion by the authors that a secular variation of the ozone in the terrestrial stratosphere occurs with solar activity. The ozone content between 20 and 30 km altitude is shown graphically for the years 1951 to 1972; each point represents the average of 50 to 75 balloon ascents from stations in Germany and Switzerland. The values show a marked decrease with decrease in sunspot number, and there is a good correlation between ozone content and solar activity. A simple equation is deduced for the ozone content as a function of sunspot number, according to which the ozone content in the lower stratosphere would vary by 10% within a solar cycle of mean amplitude. From this a variation of only a few % follows for the total ozone amount, which could scarcely be detected from the ground due to the wide variations below 20 km caused by meteorological mechanisms. The chief variations appear to occur between 20 and 30 km; and above this no significant variation could be detected. From the data it appears that the mean variations of total ozone during a solar cycle may not exceed 3%. Explanations for the observed effect of solar activity on ozone content are discussed. (UK)

10327 ENHANCED ELECTRON PRECIPITATION IN BRAZILIAN MAGNETIC ANOMALY IN ASSOCIATION WITH SUDDEN COMMENCEMENT. Martin, I. M.; Rai, D. B.; Da Costa, J. M.; Palmeira, R.; Trivedi, N. B. (Instituto de Pesquisas Espaciais, Sao Jose Dos Campos, Brazil). Nature (London) Phys. Sci.; 240: No. 100, 84-6(27 Nov 1972).

Following the first satellite observations of enhanced particle flux in the region of this anomaly various attempts have been made to detect effects associated with the precipitation of radiation-belt particles over the region of the anomaly at balloon altitudes. During flights on December 17, 1971 a moderate geomagnetic storm occurred at an altitude of ~3 mbar, and marked changes in the measured particle flux were observed in association with the changes in magnetic field. As well as pointing out the foregoing, results obtained on April 6, 1972 during a magnetically quiet period are discussed, when it is thought that the first direct detection of particle precipitation in the magnetic anomaly at balloon altitudes was obtained. The charged-particle detector consisted of a single cylindrical plastic scintillator, viewed with a photomultiplier. The particle counting rate increased about four times with occurrence of the sudden commencement. (UK)

10328 SHALLOW-SOLAR-ZENITH-ANGLE CONTROL OF TOPSIDE IONOSPHERIC PARAMETERS. Soicher, H. (Army Electronics Command, Ft. Monmouth, NJ). Nature (London) Phys. Sci.; 240: No. 101, 107-9(4 Dec 1972).

It is stated that large latitudinal variations in topside ionospheric electron densities and scale heights were observed during October and November 1963, as shown by ionograms obtained by the Alouette-I topside sounder as it traversed regions over the North American continent experiencing local sunrise at ionospheric heights. Variations in topside electron densities, scale heights, and related parameters with solar zenith angle at local sunrise are given for fixed latitudes of 45, 55, and 60°N geomagnetic latitude during the foregoing period and these variations are discussed. (UK)

10329 VLF ATMOSPHERICS PARAMETERS DESCRIBED BY THE WAIT AND WALTERS MODEL. Harth, W. (Max-Planck-Institut fuer Radioastronomie, Bonn). Z. Geophys.; 38: No. 1, 153-67(May 1972). (In German).

The classical Wait and Walters model and the "surface impedance concept" is the basis for a first approach in the discussion of the vlf atmospherics parameters as measured by the vlf atmospherics analyzer of the Heinrich-Hertz-Institut in Berlin-Charlottenburg. Since the analyzer is mainly tuned to frequencies within the lower vlf range (3 to 10 kHz), the mode calculations by Wait and others are extended to this range. From attenuation rates and phase velocities the parameters GDD (Group Delay Time Difference) and SAR (Spectral Amplitude Ratio) of spectral groups are derived. These parameters show a significant dependence on the propagation direction relative to the Earth's magnetic field and are—for far-away thunderstorms—proportional to the distance. The selection of this simplified model is justified by the good agreement with the measurements. All calculations presented in this paper refer to the first mode. (tr-auth)

10330 METHODS OF ANALYZING THE FREQUENCY SPECTRA OF ATMOSPHERIC GRAVITY WAVES IN THE IONOSPHERE. Schoedel, J. P.; Muench, J. W. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Z. Geophys.; 38: No. 1, 169-77 (May 1972). (In German).

Measurements of the ionospheric electron content can be used in order to observe atmospheric gravity waves. The spectra of the waves can be computed by means of numerical filters and by the method of a statistical frequency-analysis. (tr-auth)

10331 POTENTIAL DOUBLE LAYERS IN THE IONOSPHERE. Block, L. P. (Royal Inst. of Tech., Stockholm). Cosmic Electrodyn.; 3: No. 3, 349-76(Oct 1972).

Langmuir's old theory of double layers is reviewed and extended to ionospheric conditions, including effects of gravity and expansion in diverging geomagnetic flux tubes. Bohm's self-consistency condition is refined by including the temperature of the beam particles. Chances for stable sheaths are greatest at altitude 1000 to 3000 km on closed field lines, or higher on open plasma-sheet field lines, and near the F-region maximum for upward currents, according to observations. Randomly arising and disappearing double layers may cause anomalous resistivity in regions where the plasma is subject to rarefaction instabilities, namely in the polar wind for upward currents, below the F-region maximum for downward currents, and in the topside ionosphere in a limited region at perhaps altitude 1000 to 5000 km. When double layers occur plasma is accelerated upwards, and the topside electron density may be reduced considerably within minutes. At the same time the electric fields in the double layers accelerate large fluxes of particles, both downwards as precipitation, and upwards as energetic particles, preferably observed in the midnight sector, e.g., at synchronous altitude. However, in spite of the very large fluxes there is no particle depletion problem, since current systems are always closed. Electrostatic parallel electric fields can also be constructed, such that both electrons and protons precipitate at the same place. (39 references.) (auth)

Effects of Nuclear Detonations

Refer also to abstract 10307.

Magnetospheric Phenomena

Refer also to abstracts 10305, 10307, and 11183.

10332 (AD-744954) ANISOTROPIES IN THE INTERPLANETARY INTENSITY OF SOLAR PROTONS >0.3 MeV. Innanen, W. G.; Van Allen, J. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jun 1972. Contract N00014-68-A-0196-0003. 60p. NTIS.

Data on solar protons of energy >0.3 MeV obtained by Explorer 35 since July 1967 were selected for the detailed study of intensity vs time and of angular distributions of intensity in interplanetary space near the Earth: November 18, 1968; August 9, 1967; May 13, 1969; January 24, 1969; March 21, 1969; June 25, 1970; January 31, 1970; July 1, 1970; November 27, 1967; and July 6, 1970. The bases of selection were that the events be of adequate intensity for statistically satisfactory study and that they be "simple"—that is, reasonably attributable to a single solar flare so that their time histories were not complicated by overlapping emissions of particles. The principal findings for these events are discussed in the report. (auth)

10333 EFFECT OF AN ELECTRIC FIELD INDUCED BY A TIME-DEPENDENT RING CURRENT ON THE PARTICLE DRIFT MOTION. Wang, C. S.; Kim, J. S. (State Univ. of New York, Albany). Planet. Space Sci.; 20: No. 12, 2039-44(Dec 1972).

The effect of an electric field induced by a rapidly decaying ring current on the motion of charged particles in the magnetosphere was investigated using Euler potentials. For a model consisting of the Earth dipole and the symmetric ring current, the electric field satisfies the condition $E \times B = 0$. Under this circumstance, the $E \times B$ drift of the particle can be identified as the motion of the magnetic-field lines, and vice versa. The time-dependent electric field induced can be evaluated in a spherical polar coordinate system by the formula $E \cdot (\delta\beta/\delta t) \nabla\alpha - (\delta\alpha/\delta E) \nabla\beta$ where α and β are Euler potentials. A model calculation on the particle-drift velocity $v_D = E \times B/b^2$ shows that the radial component of the drift velocity is in good agreement with those deduced from whistler duct studies. (auth)

10334 SELF-CONSISTENT GEOMAGNETIC TAIL UNDER STATIC CONDITIONS. Bird, M. K.; Beard, D. B. (Univ. of Kansas, Lawrence). Planet. Space Sci.; 20: No. 12, 2057-72(Dec 1972).

A self-consistent calculation of the magnetic-field and plasma distribution in the magnetotail was undertaken for static conditions. The best agreement was found with experimental observations by satellite in the tail for an isotropic particle pitch-angle distribution, a slow decrease of magnetic-field intensity as a function of distance from the Earth $|x|^{-0.3}$, and a northward field in the equatorial plane of about 1 gamma at the position of the lunar orbit. Knowing the field and plasma distribution, the sources of the electrical current were calculated, and it was found that the magnetic field in the tail can be supported entirely by solar wind drifting into the curved and diminishing magnetic field of the magnetotail. Furthermore the plasma present in the tail at any one instant is swept out in a very short time due to its large-curvature drift velocity; the constant plasma sheet is maintained by constant renewal of entering solar-wind plasma. (auth)

10335 SATELLITE STUDY OF THE MID-LATITUDE TROUGH IN ELECTRON DENSITY AND VLF RADIO EMISSIONS DURING THE MAGNETIC STORM OF 25–27 MAY 1967. Tulunay, Y.; Hughes, A. R. W. (Univ. of Birmingham, Eng.). J. Atmos. Terrest. Phys.; 35: No. 1, 153-63(Jan 1973).

The locations of the midlatitude trough in electron density and vlf emissions during the magnetic storm of May 25 to 27, 1967 are studied from observations made on the Ariel-3 satellite. It is shown qualitatively that the response of the midlatitude trough to magnetic activity agrees well with the time-dependent convection model of the plasmapause derived by Grebowsky (J. Geophys. Res., 75: 4329(1970)). There is also evidence in the data that plasma is detached from the afternoon sector of the plasmasphere. In the afternoon, during the recovery phase of the storm, vlf emissions are observed close to and inside the plasmapause. It is suggested that this implies that the plasmapause may be responsible for the erosion of the ring current as suggested by Russell and Thorne (Cosmic Electrodynamics, 1: 67(1970)). However, in the morning, emissions occur polewards of the plasmapause suggesting that ring-current erosion by the plasmapause is not important in this sector of the magnetosphere. (auth)

10336 INJECTION OF LOW-ENERGY ELECTRONS INTO A MAGNETIC TRAP. Yashukov, V. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1227-8(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1535-7(Jul 1972).

A method of local injection of low-energy electrons into a magnetic trap by means of crossed E and M fields is described. Multiple passage of electrons past the injector without collision was observed experimentally. (auth)

10337 STUDY OF SELF-CONSISTENT RING-CURRENT MODELS. Sckopke, N. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Cosmic Electrodyn.; 3: No. 3, 330-48(Oct 1972).

A number of stationary, axially symmetric, ring-current models have been computed, to study the influence of certain parameters on the self-consistent solutions. These parameters were the particles' pitch-angle distribution and the vacuum field. The pitch-angle distribution has been varied for particle belts with identical equatorial energy-density profiles, and for belts with equal energy content. Most of the models have been computed for two different vacuum fields B_0: for an unbounded dipole field, and for a dipole confined by a spherical magnetopause. The virial theorem has been rewritten for this latter field model. The change in b(0), the ring-current field near the Earth, that is introduced by this modification of B_0, is comparable to the difference between the linear approximation and the self-consistent solution of b(0) for a given vacuum field. This difference is of the order of 10% for the model belts considered, even for the strongest one, which corresponds to Dst $\approx 250\ \gamma$, and which is thought to be a reasonable extrapolation of the weaker disturbances that have been observed. Given the uncertainties of the particle measurements as well as those in the knowledge of the vacuum field, this result seems to indicate that the linear approximation for b(0) will be adequate for almost all practical purposes. (27 references) (auth)

10338 STABILITY OF A MODEL CURRENT SHEET WITH FINITE TRANSVERSE FIELD AND FINITE FLOW VELOCITY. Smith, D. F.; Raadu, M. A. (National Center for Atmospheric Research, Boulder, CO). Cosmic Electrodyn.; 3: No. 3, 285-96 (Oct 1972).

The stability of a model current sheet with finite transverse field and finite axial flow velocity that are taken as constant across the sheet was investigated for stability in the infinite conductivity MHD limit. This approach limits the analysis to cases where flow is subsonic, but either sub- or super-Alfvenic in the sheet. The current sheet was found to be stable to perturbations perpendicular to the plane of the sheet for a large range of parameters. These results may be useful in constructing models of parts of coronal streamers and the geomagnetic tail. (auth)

10339 EQUILIBRIUM CONFIGURATION OF THE GEOMAGNETIC TAIL. Cole, G. H. A.; Schindler, K. (European Space Research Inst., Frascati, Italy). Cosmic Electrodyn.; 3: No. 3, 275-84(Oct 1972).

Conditions of momentum balance in the geomagnetic tail are investigated on the basis of a simple steady two-dimensional model. It is concluded that available observations on the tail structure can be explained within this frame-work during times when the tail is sufficiently quiet. It is shown that the existence of a finite-β plasma sheet appears as a consequence of the observed magnetic-field variation along the tail. Given present observations, pressure anisotropy and waves are not likely to contribute significantly to the momentum balance along the tail. It is concluded further that there is a need for more detailed observational data to help to assess the validity of the present model. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

Refer also to abstracts 10954 and 11244.

10340 (CEA-CONF-2028) DETECTION OF NEUTRAL ATOMS WITH ENERGY BETWEEN 250 eV AND 3 keV. Girard, J. P.; Monnom, G.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 6p. (In French). (CONF-720552-2). Dep. NTIS (U. S. Sales Only).

From 6th conference on collisions of atoms and electrons; Liege, Belgium (17 May 1972).

The measurement of the ionic temperature of a hot plasma is often made by the detection of the neutral atoms escaping from the plasma. The atoms are reionized either in a gas cell or by passage across a metallic foil. The calibration of both a gas cell and a carbon foil for neutral atoms with energy between 250 eV and 3 keV is described. The systems of ionization are compared. (J.S.R.)

10341 (LYCEN-7242) INELASTIC SCATTERING OF ELECTRONS BY XENON. ENERGY OF THE EJECTED ELECTRONS. Hadinger-Espi, G.; Hadinger, G. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 11p. (In French). Dep. NTIS (U. S. Sales Only).

In the course of studies utilizing the Monte Carlo method, a simple law was established giving the energy of electrons ejected from xenon atoms or ions as a function of the energy of the incident electrons. (France)

10342 INSTABILITIES OF AN AZIMUTHAL RELATIVISTIC ELECTRON BEAM WITH A SPREAD IN THERMAL VELOCITY. Pastukhov, V. P. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 882-8(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1104-12(Jun 1972).

The high-frequency instabilities of an azimuthal beam (a cylindrical current of relativistic electrons) in a magnetic field are treated when there is a thermal spread in the beam. If the frequency is near one of the electron-cyclotron harmonics, the thermal spread gives rise to an instability of the azimuthal modes with $l + s$, $s > 1$ (l is the number of the cyclotron harmonic), not only the modes with l and $l + 1$. The growth rates are found. It is also shown that axisymmetric perturbations are stable at both high and low frequencies. (auth)

10343 ELECTRON BEAM EMITTED THROUGH THE MESH ANODE OF A TURBULENT DISCHARGE. Babichev, A. P.; Muromkin, Yu. A.; Gorbunova, E. F.; Martsynk'yan, V. L. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 969-73 (Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1219-23(Jun 1972).

The characteristics of the stream of electrons striking the anode of a turbulent discharge are studied by means of an electrostatic analyzer. The discharge is excited along a magnetic field of 1.5 kOe between a solid electrode and a mesh electrode in a glass vacuum chamber 10 cm in diameter. The chamber is initially filled with hydrogen plasma with density variable in the range 5×10^{12} to 2×10^{13} cm^{-3}. The capacitance of the straight discharge circuit $C_{st.d} = 0.2$ μF, the initial voltage $U_C = 15$ to 30 kV, and the maximum current ~20 kA. The discharge is found to contain electrons whose mean energy depends on the voltage drop across the discharge resistance; the current density of the beam is of the same order as the density of the discharge current. A reverse electron current which balances the current of the beam beyond the mesh anode is observed. (auth)

10344 ELECTROMAGNETIC RADIATION FROM A MODULATED ELECTRON BEAM. Pankratov, S. G.; Samoshenkov, Yu. K.; Sokolov, A. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 1050-1(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1320-1(Jun 1972).

The intensity of the electromagnetic radiation from a modulated beam of nonrelativistic electrons in a field-free empty space is estimated. The radiation is due to the interaction between beam electrons. The beam is described by a linearized system of hydrodynamic equations, from which the beam current is found. The boundary conditions are the values of the variable components of the density, velocity, and modulating field at the point at which the beam enters the vacuum. The transverse spread of the beam is neglected since the modulating frequency is assumed to be high in comparison with the reciprocal of the characteristic time for transverse spreading of the beam. (M.O.W.)

10345 SCATTERING OF DIATOMIC AND POLYATOMIC MOLECULES FROM THE (100) CRYSTAL FACE OF PLATINUM. West, L. A.; Somorjai, G. A. (Univ. of California, Berkeley). J. Chem. Phys.; 57: No. 12, 5143-53(15 Dec 1972).

The angular distributions of thermal-energy molecular beams of diatomic (CO, N_2, O_2, NO, H_2, D_2) and polyatomic (CO_2, N_2O, C_2H_2, NO_2, NH_3, and methylene cyclobutane) molecules were monitored following scattering from the (100) crystal face of platinum. All of the gases studied (with the exception of ammonia) yielded directed scattering patterns with the maximum intensity peaked at or near the specular angle for scattering from a clean platinum surface or from a platinum surface covered by a layer of ordered graphite. Broad, cosine-like angular distributions independent of incident angle were observed, however, for the cases of C_2H_2 scattered from an adsorbed layer of C_2H_2 and CO scattered from adsorbed CO. These results seem to indicate that efficient energy transfer between the surface atoms and gas molecules, as indicated by angular distributions, occurs only in specific instances. Apparently, the incident particles are reflected whenever the nonlocalized vibrational energy modes of surface atoms and the translational energy of the incident molecules are of similar magnitude. The adsorption of gases may lead to the formation of additional low-frequency localized surface modes that can be excited by the incident molecules. The efficient transfer of energy via localized surface modes would increase the residence time of the incident molecules and could thus account for the cosine-like angular distributions observed for C_2H_2 and CO. (auth)

10346 INFLUENCE OF SURFACE CONTAMINATION ON THE FINE STRUCTURE OF THE ANGULAR CHARACTERISTICS OF THE SECONDARY ELECTRON EMISSION COEFFICIENT OF SINGLE CRYSTALS. Korablev, V. V. (Leningrad Polytechnic Inst.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1539-41 (Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1789-91(Jun 1972).

A study was made of the effects of a carbon surface monolayer on the angular dependence $\sigma(\varphi)$ of the secondary electron emission coefficient of tungsten single crystals in the primary electron energy range $E_p = 100$ to 1000 eV. The surface monolayer was formed by heating the tungsten single crystal to ~2000°C, which caused the carbon impurity to diffuse to the surface. Auger spectroscopy and LEED were used to determine the state of the surface. Results showed that for $E_p = 120$ eV, the carbon layer reduced the amplitude of the fine-structure peaks in $\sigma(\varphi)$ by a factor greater than 4, while for higher E_p values, the changes were slight. (D.L.C.)

10347 ATTENUATION METHOD FOR FAST ION BEAMS. METASTABLE STATE POPULATION AND CROSS SECTION MEASUREMENTS. Vujovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade); Matic, M.; Cobic, B.; Gordeev, Yu. S. J. Phys., B (London); 5: No. 11, 2085-97(Nov 1972).

An attenuation method for a two-component singly charged ion beam, which enables the beam metastable fraction to be determined and nearly pure ground- and metastable-state beams to be produced, is described. The role of the collisionally induced excitation and de-excitation processes occurring during the beam attenuation process is analyzed in detail. The possibility of determining the corresponding cross section σ_{11^*} and σ_{1^*1} from the attenuation data is considered also. As an illustration of the method, the results of the analysis for the attenuation of a 10-keV N^+ ion beam in argon are given. The electron-capture cross sections for ground- and metastable-state ions and the de-excitation cross section are obtained with an estimated uncertainty of about 20%: $\sigma_{10} = 12.4 \times 10^{-16}$ cm^2, $\sigma_{1^*0} = 3.1 \times 10^{-16}$ cm^2, and $\sigma_{1^*1} = 3.5 \times 10^{-16}$ cm^2. The cross section for the excitation of the metastable state involved is estimated to be $\sigma_{11^*} < 2 \times 10^{-17}$ cm^2. (auth)

10348 VERSATILE PHOTO-ETCHED VELOCITY SELECTOR DISC. Giles, R. A.; Logan, J. A. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 11, 2123-5(Nov 1972).

A thin copper–beryllium velocity selector disc is described, which is very accurate in its geometry and is cheap to produce. The design is such that six relative orientations can be easily set up to a high level of precision. (auth)

10349 SCATTERING OF ALKALI METAL IONS BY THE SURFACE OF ALLOYED TARGETS OF NbTi AND SiC. Arifov, U. A.; Khadzhimukhamedov, Kh. Kh.; Yunusov, A. I. (Inst. of Electronics, Tashkent. Tashkent State Univ.). Izv. Akad.

Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 55-7(1971). (In Russian).

Targets of NbTi, α-Sic, and their components were bombarded with 0.2- to 4-keV alkali metal ions. Curves show the scattering coefficients obtained as functions of incident-ion energy and mass and of target mass. From the shape of these experimental curves an empirical formula for the scattering coefficient is derived. (A.G.W.)

10350 LOSS COEFFICIENT OF ATOMIC OXYGEN ON METAL SURFACES. Lake, L. R. Minneapolis; Univ. of Minnesota (1972). 108p. University Microfilms Order No. 72-27,840.

Thesis.

The loss coefficient of atomic oxygen on metal surfaces for an incident flux of 10^{13} atoms/cm^2/s is found to be 0.5 ± 0.1 for aluminum, graphite, stainless steel, and a combination of Nichrome V and Alnico V. There is an indication that the loss coefficient on gold may be substantially less. The measurements are made by directing an atomic oxygen beam into a mass spectrometer ion source and noting the relative mass spectrometer signals, when various portions of the incoming beam are blocked. The loss coefficients are deduced from these ratios, using a calculated model for the interreflection of molecules in the ion source. By using oxygen enriched in the ^{18}O isotope as a tracer, it is confirmed that some of the atomic oxygen lost at the surfaces reappears in carbon dioxide. The release of carbon dioxide appears to involve one carbon atom and one oxygen atom from the surface, and one oxygen atom from the beam. The carbon dioxide signal is found to respond to a step change in atomic oxygen flux with a time constant of several minutes. (Diss. Abstr. Int., B)

10351 ENERGY SPECTRA OF Cs^+ IONS SCATTERED FROM THE SURFACE OF A TUNGSTEN SINGLE CRYSTAL. Veksler, V. I.; Evstifeev, V. V. (Tashkent State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1178-80(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1479-81(Jul 1972).

The fine structure in the energy spectra of Cs^+ ions scattered from the {001} plane of a tungsten single crystal is investigated for various incidence angles of the primary ions. A model of group interactions and a mechanism of two-step binary collisions is invoked to explain the results obtained. (auth)

Atomic and Molecular Properties

Refer also to abstracts 10391, 10419, and 10710.

10352 (IAE-2174) CONCERNING THE POSSIBILITY OF AN INCREASE ON PHOTODISSOCIATED TRANSFERS. Yakovlenko, S. I. (Institut Atomnoi Energii, Moscow (USSR)). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The possibility of an intensification in the photodissociative transitions from thermally stable electron-excited states of molecules to low-lying disperse (or unstable) electron states is considered. The basic state of a molecule was selected as the disperse state. A condition for the intensification of radiation was obtained as associated with the analog of the effective width of the line. The coefficient of intensification was related to the structure of the disperse term. The inverse of the photodissociative transitions was easily achieved, however, the coefficients of intensification were essentially smaller than, for example, for transitions in atoms. In simplified propositions a connection was found between the coefficient of intensification and the parameters of recombined density of low-temperature plasma. Estimates are given for the possible production of a generation on photodissociative transitions. (tr-auth)

10353 (ORO-3346-108) NUCLEAR AND X-RAY SPECTROSCOPY WITH RADIOACTIVE SOURCES. Eighth Annual Progress Report. Fink, R. W. (Georgia Inst. of Tech., Atlanta. School of Chemistry). 31 Oct 1972. Contract AT(40-1)-3346. 18p. Dep. NTIS.

The major emphasis was on the investigation of L-subshell fluorescence and Coster–Kronig yields, particularly of the L_2 and L_3 subshells from Z = 65 to 96. Related work involved measurements on other atoms and also K-shell yields. A major off-campus activity was participation in the UNISOR project. Numerous papers and talks on the work accomplished have been presented. (R.W.R.)

10354 MOMENT FUNCTIONS OF THE HYDROGEN MOLECULAR ION. Bates, D. R. (Queen's Univ., Belfast). Chem. Phys. Lett.; 17: No. 2, 184-5(15 Nov 1972).

The moment functions of H_2^+ are computed for internuclear distances up to $5a_0$ from the dipole oscillator strengths. (auth)

10355 COMPUTATION OF ACCURATE CORRELATION ENERGIES USING STRONG-ORTHOGONAL CORRELATION FUNCTIONS. Bendazzoli, G. L. (Istituto di Chimica Fisica e Spettroscopia, Bologna); Bernardi, F.; Palmieri, P. Chem. Phys. Lett.; 17: No. 2, 277-9(15 Nov 1972).

Correlation energies are computed for the ground state of He, using various Hylleraas-type correlation factors, according to $E' = E - E_0$, where E refers to the total energy and E_0 to the energy computed in the single determinant approximation, involving the same orbitals used for the computation of E. It is shown that this procedure provides accurate estimates of the correlation energy, when the correlation functions are "strong-orthogonal" to the corresponding uncorrelated wave functions. (auth)

10356 DOUBLE-EXCHANGE CONTRIBUTIONS TO THE FIRST-ORDER INTERACTION ENERGY BETWEEN CLOSED-SHELL MOLECULES. van Duijneveldt-van de Rijdt, J. G. C. M.; van Duijneveldt, F. B. (Univ., Utrecht). Chem. Phys. Lett.; 17: No. 3, 425-7(1 Dec 1972).

Explicit formulas are presented for the double-exchange first-order interaction energy of two closed-shell molecules. Calculations on He_2 show that the double-exchange terms contribute significantly for R < 3.5 au. (auth)

10357 PHOTODISSOCIATION OF H_2^+ BY MONOCHROMATIC LIGHT WITH ENERGY ANALYSIS OF THE EJECTED H^+ IONS. Ozenne, J. B.; Pham, D.; Durup, J. (Paris Univ., Orsay, France). Chem. Phys. Lett.; 17: No. 3, 422-4(1 Dec 1972).

Kinetic energy spectra of H^+ ions produced by photodissociation of fast H_2^+ ions by a ruby laser beam polarized either parallel or perpendicular to the ion beam are obtained. For the former polarization direction the spectrum shows a structure which reflects the vibrational levels of the primary ions that undergo dissociation. (auth)

10358 NONEMPIRICAL APPROXIMATE CALCULATIONS FOR THE GROUND STATES OF H_2 AND H_3 INCLUDING COMPLETE CONFIGURATION INTERACTION. Koster, J. L.; Ruttink, P. J. A. (Univ., Utrecht). Chem. Phys. Lett.; 17: No. 3, 419-21(1 Dec 1972).

Calculations are reported for the ground states of H_2 and H_3 in which the original atomic orbital basis is transformed to a symmetrically orthonormal atomic orbital basis. Complete configuration interaction is carried out and the results are shown to be in good agreement with ab initio calculations. (auth)

10359 CALCULATION OF THE INTERMEDIATE COUPLING BETWEEN THE HUND'S CASES b AND d, FOR THE 3d RYDBERG STATES OF H_2. Jost, R. (Univ. Scientifique and Medicale, Grenoble, France). Chem. Phys. Lett.; 17: No. 3, 393-6(1 Dec 1972).

The calculation of an intermediate coupling between the Hund's cases b and d is made in the d basis. The calculation is applied to the 3d $^1\Sigma$, $^1\Pi$, $^1\Delta$ states of H_2 in order to interpret the measured g factors of the $^1\Sigma$ state. The g factors of these states obtained by the calculations of the other authors in the b basis are compared with the present results. It is concluded that the criterion of isolation of the 3d Rydberg states of H_2 is not valid. (auth)

10360 EFFECT OF ROTATION ON THE COMPUTED THERMAL DISSOCIATION RATE OF H_2. Dove, J. E.; Jones, D. G. (Univ. of Toronto). Chem. Phys. Lett.; 17: No. 1, 134-6(1 Nov 1972).

The thermal dissociation rate of H_2 dilute in argon between 1500 and 15,000°K was calculated using the model of a rotating anharmonic oscillator for the diatomic molecule. The coupled differential equations that govern the populations of all the vibration–rotation levels of para-H_2 were solved numerically. The results show that the inclusion of the effects of rotation in the calculations greatly increases the dissociation rate and lowers the computed Arrhenius activation energy to give substantial agreement with experimental measurements in normal H_2. (auth)

10361 MOBILITIES OF URANIUM AND MERCURY IONS IN HELIUM. Johnsen, R.; Biondi, M. A. (Univ. of Pittsburgh). J. Chem. Phys.; 57: No. 12, 5292-5(15 Dec 1972).

The mobilities of mass-identified U^+ and Hg^+ ions in helium were determined in a drift-tube–mass-spectrometer apparatus. For uranium ions a reduced mobility value $\mu_0 = (16.0 \pm 0.5)$ cm^2/V·s is obtained at 305°K and a standard gas density of 2.69×10^{19} cm^{-3}. The mobility of mercury ions is $\mu_0 = (19.4 \pm 0.5)$ cm^2/V·s at 292°K, in agreement with two previous determinations. The effect of fast ion injection in drift mobility measurements is discussed, and a new technique to circumvent these problems is described. The results are compared with existing theories of ion mobilities. (auth)

10362 $L\beta_1'$ SATELLITE IN THE X-RAY SPECTRA OF RARE EARTHS. Garg, K. B.; Kapoor, Q. S.; Nigam, A. N. (Univ. of Rajasthan, Jaipur, India). J. Phys., B (London); 5: No. 11, 2152-4(Nov 1972).

Using a 40-cm curved-crystal spectrograph of the transmission type, the existence of the high-frequency satellite $L\beta_1'$ in the x-ray spectrum of thulium (λ = 1518.9 xu) was established for the first time. The wavelength of this satellite in the case of some other rare earths was remeasured. Based on the multiple ionization theory, the satellite was assigned to the transition $L_{II}M_I \rightarrow M_IM_{IV}$. The wavelength values calculated on this level scheme show good agreement with the measured wavelength values for $L\beta_1'$, lending thereby further support to the validity of the multiple ionization theory. Identification of $L\beta_1'$ as octupole transition $L_{II}M_V$ in the case of Tm, Dy, Tb and Gd by earlier workers is critically examined. (auth)

10363 POLARIZABILITY OF HELIUM. Thomas, M. A.; Humberston, J. W. (University Coll., London). J. Phys., B (London); 5: No. 11, L229-32(Nov 1972).

The Rayleigh–Ritz principle is used to generate a series of systematically improving helium ground-state wave functions. The polarizabilities of these wave functions are calculated by the method of Baber and Hassé (Proc. Camb. Phil. Soc., 33: 1310-7 (1937)), and the convergence of the values with the improvement in the helium wave function is studied resulting in an extrapolated value of $(1.3834 \pm 0.001)a_0^3$. (auth)

10364 USE OF THE WKB APPROXIMATION FOR SOLVING HARTREE–FOCK EQUATIONS. Gataullin, R. M.; Arifov, P. U. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 10, 3-4(1971). (In Russian).

The WKB approximation yields accurate values for single-electron energies in calculations with hydrogen-like ions in those cases where the potential is associated with a Coulomb field. The accuracy of the WKB approximation has not been tested for potentials of a self-consistent Hartree–Fock field. Testing was conducted with a series of negative ions: H^-, Li^-, B^-, C^-, N^-, O^-, and F^-. (K.S.W.)

10365 AUGER ELECTRON SPECTROSCOPY OF THE LANTHANIDE RARE EARTH ELEMENTS. Maddox, K. P. Norman, OK; Univ. of Oklahoma (1972). 85p. University Microfilms Order No. 72-29,901.

Thesis.

Auger electron spectroscopy (AES) was used to investigate the lanthanide rare earth series. Spectra obtained with a cylindrical mirror analyzer were identified in x-ray notation for transitions between atomic energy levels. Systematic shifts in energy with increasing atomic number are tabulated and described. Intensity variations between peaks are shown in reproduced spectra and described in semi-quantitative terms. Ionization loss peaks were used to identify transitions and supplement x-ray data for the lower energy levels. Comparison between the data reveals large differences for energies less than 160 eV. Calculated Auger energies are shown to be in close agreement with experiment only if ionization loss data are employed. Calibration of Auger energies by reference to elastic backscattered electrons is discussed. A constant difference of 4.5 eV is found between Auger energies thus calibrated and previously reported data. (Diss. Abstr. Int., B)

10366 X-RAY FLUORESCENCE YIELDS, AUGER, AND COSTER–KRONIG TRANSITION PROBABILITIES. Bambynek, Walter (EURATOM, Geel, Belgium); Crasemann, Bernd; Fink, R. W.; (and others). Rev. Mod. Phys.; 44: No. 4, 716-813(Oct 1972).

The present status of the field of fluorescence yields, radiationless (Auger and Coster–Kronig) and radiative transition probabilities is summarized. Tables of experimental and theoretical results are included, and tables of "best values" of important quantities are presented. (497 references) (auth)

10367 MODEL DESCRIBING THE RUTHERFORD EXPERIMENTS ON ALPHA-PARTICLE SCATTERING. Mikhalevskii, V. S. (Rostov State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 147-8(1972). (In Russian).

A lecture-table model was devised for illustrating a simple and visual confirmation of conclusions regarding the small dimensions of nuclei and the planetary structure of the atom on the basis of Rutherford's alpha-particle scattering experiments. The model also depicts the character of scattering as a function of the effective cross sections of the scattering centers. (K.S.W.)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstract 10571.

10368 PION–NUCLEUS OPTICAL POTENTIAL AND MESIC ATOMS. Scheck, R. (SIN–ETH, Zurich); Wilkin, C. Nucl. Phys.; B49: 541-56(1972).

It was suggested that pionic atoms could be described by a local pion–nucleus potential rather than the more conventional momentum-dependent potential. These potentials give remarkably different answers for the energy shifts and level widths of such systems. It is pointed out that when the effects of short-range correlations are included in the two potentials there is in fact very little difference between them. The local potential requires a slightly more positive isoscalar πN scattering length than the nonlocal one. (auth)

10369 MUONIUM FORMATION IN SLOW COLLISIONS OF POSITIVE MESONS WITH HYDROGEN ATOMS. Janev, R. K.; Belkic, Dz. S. (Inst. of Physics, Belgrade). J. Phys., B (London); 5: No. 11, L237-9(Nov 1972).

The process of muonium formation in slow collisions of positive mesons with hydrogen atoms is considered in the energy range of 0.4 eV to 5 keV using adiabatic methods for near-resonant atomic reactions. (auth)

10370 EXCITED STATES OF POSITRONIUM. Curry, S. M. Stanford, CA; Stanford Univ. (1972). 91p. University Microfilms Order No. 72-30,618.

Thesis.

Formation of positronium in fine metallic oxide powders is studied in an attempt to detect positronium formed in excited states. It is discovered that free positronium can be obtained in a vacuum environment by irradiating with positrons a thin layer of magnesium oxide powder suspended in vacuum on a gold foil. Measurements are made of the efficiency of the thin powder layer for producing free positronium and of the average kinetic energy of the positronium escaping from the powder layer. Other metallic oxide powders are found to produce free positronium. An experiment is performed to detect positronium formed by the MgO powder in the n = 2 excited state, based on the crossing of the $^3S_1$ (± 1) and $^3P_2$ (0) energy levels at a critical value of the applied magnetic field. The experiment was inconclusive because the effect of the motional electric field experienced by positronium moving perpendicular to the magnetic field was much greater than expected. Calculations are presented of the fine structure and lifetimes of the n = 2 state of positronium under the influence of crossed electric and magnetic fields. A monochromator is used in an experiment to look for the Lyman-alpha radiation emitted by excited positronium escaping from a powder surface into vacuum. No evidence of Lyman-alpha radiation is found, indicating that less than 6% of the free positronium emits Lyman-alpha radiation before it annihilates. (Diss. Abstr. Int., B)

10371 REALITY OF THE INNER STATE IN THE KAONIC ATOM. Atarashi, M.; Narumi, H. (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1427-8(Oct 1972).

Two distinct types of eigenstates in the soluble model have been pointed out [Koch, et al., Phys. Rev. Lett., 26: 1465 (1971)], where the system with imaginary square well potential was introduced to explain an unexpected variation of a complex level shift in the kaonic atom. One state is the outer state, for which the mesic wave function is localized in the outer region of a nucleus; the other is the inner state, for which the meson is bound almost inside the nucleus, and its wave function is strongly attenuated outside the nucleus. Attention is directed to the reality of these states. It is found that the imaginary part of the nuclear potential gives a repulsive effect to the bound kaon wave function. The complex level shift of the 3d state for ^{32}S is calculated by perturbation theory and by exact numerical solution of the Klein–Gordon equation. The results show that it is not safe to apply perturbation theory to the calculation of the complex level shift for the kaonic atom in this case. It is concluded that the realistic kaonic bound state can not be divided into two distinct eigenstates, and might better be regarded as the outer state with a correction in the vicinity of the nuclear surface. Nevertheless, the kaon probability density in the nuclear region depends on the interaction strength in a way similar to the inner state, i.e., the number of nodes of the kaonic wave function in the inner region increases with the strength of the attraction except for the s states. Including the effect of the Y_0^* resonance reinforces this conclusion. (1 figure, 1 table) (R.W.R.)

Collision Phenomena

Refer also to abstracts 9381, 10347, 10369, 10421, 11167, and 11253.

10372 (CEA-N-1560) TOTAL CROSS SECTIONS FOR COLLISIONS OF METASTABLE ARGON ATOMS WITH RARE GASES

AND SOME SIMPLE MOLECULES. Nenner, Thomas (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1972. 123p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay (France).

The total cross sections for collisions between metastable argon atoms and rare gases (Ne, Ar, Kr, or Xe) or simple molecules (D_2, N_2, or CO) were determined from measurements of the attenuation experienced by the metastable beam after traversing a collision chamber. The curves representing the variations in the total cross sections as a function of the velocity of the metastable atoms are compared to the curves calculated for elastic collisions with a Lennard-Jones type interaction potential. The properties of metastable argon are similar to those of potassium. (France)

10373 (ORO-4325-4) IONIZATION PHENOMENA. Progress Report, January 1, 1972-November 30, 1972. Watson, R. L. (Texas Agricultural and Mechanical Univ., College Station. Cyclotron Inst.). [nd]. Contract AT(40-1)-4325. 73p. Dep. NTIS.

Completed work on the following is reported: carbon K- and argon L-Auger electron yields resulting from impact ionization by equal-velocity alpha particles and deuterons, intense satellite lines in carbon K- and argon L-Auger spectra following impact ionization by alpha particles and deuterons, the probability for simultaneous K- plus L-shell ionization in light ion collisions, and K-shell ionization of elements from Z = 26 to 79 by high-velocity alpha particles. Data and some discussion of the data are included. A Bragg crystal x-ray spectrometer and modification of the Hartree-Fock-Slater atomic-structure program are described more briefly. Work in progress on the following is discussed: advances in the theoretical description of ionization by light ions, K_β-to-K_α intensity ratios for x-ray production by deuterons, alpha particles, and carbon ions, compilation of K-shell cross sections for ionization by H^+, $^2H^+$, and $^4He^{2+}$, and a gas cell and electrostatic analyzer system for in-beam studies of Auger electron emission. Some results are included. (A.G.W.)

10374 ION BOMBARDMENT INDUCED PHOTON AND SECONDARY ELECTRON EMISSION. Martel, J. G.; Olson, N. T. (Massachusetts Inst. of Tech., Cambridge). Nucl. Instrum. Methods; 105: No. 2, 269-75(1972).

Results of an experimental investigation of photon and secondary-electron emissions produced during inelastic collisions between energetic ions and lattice atoms are reported. Cs and Na ions, accelerated to energies of 1 to 20 keV, were used to bombard Al, Ag, Cu, Cr, Fe, Ge, and Si targets. Alkali metal ions were selected since they have no potential secondary-electron emission and direct comparisons between photon and electron emission were possible. The photon emission observed was that of the line spectra of neutral atoms and no continuous spectra, or plasma oscillation emission, was observed. The intensity of photon emission was linear with the ion beam current density up to 10 $\mu A/cm^2$ for cesium and 1 $\mu A/cm^2$ for sodium ion bombardment. Above these current densities a saturation, which is not explained, occurred. The photon emission intensity increased with ion energy up to approximately 10 keV where a saturation occurred. Target self-absorption of the emitted photons accounts for this saturation, however. The dependence of the photon emission and the secondary-electron emission upon experimental parameters was similar, but not identical. Both emissions originate in inelastic collisions although their means of escape from the target affects their dependence upon experimental parameters. (8 figures, 2 tables) (auth)

10375 COMPARISON OF THE UNIFORM WKB THEORY WITH THE LANDAU-ZENER-STUECKELBERG THEORY OF INELASTIC COLLISIONS. Eu, B. C.; Tsien, T. P. (McGill Univ., Montreal). Chem. Phys. Lett.; 17: No. 2, 256-9(15 Nov 1972).

By comparing the transition probabilities obtained by numerical uniform WKB and DWBA methods and by the Landau-Zener-Stückelberg theory for two-channel problems numerically with each other, it is found that the result by the uniform WKB method is accurate and far superior to the Landau-Zener-Stückelberg and DWBA results. (auth)

10376 VALIDITY OF THE DISTORTED-WAVE METHOD IN ELECTRON-ATOM COLLISION THEORY. Flower, D. R.; Launay, J. M. (Observatoire de Paris, Meudon, France). J. Phys., B (London); 5: No. 10, L207-10(Oct 1972).

The comparison of distorted-wave and close-coupling calculations of collision strengths for transitions in C III excited by electron collisions indicates that the distorted-wave method is sufficiently accurate for many astrophysical and laboratory applications even for atoms that are only twice ionized. (auth)

10377 MOLECULAR-BEAM TIME-OF-FLIGHT SENSITIZED FLUORESCENCE: THE VELOCITY DEPENDENCE OF $CO(a^3\Pi) + Hg(6^1S_0) \rightarrow CO(X^1\Sigma^+) + Hg(6^3P_1)$. van Itallie, F. J.; Martin, R. M. (Univ. of California, Santa Barbara). Chem. Phys. Lett.; 17: No. 3, 447-51(1 Dec 1972).

The velocity dependence of the excitation of mercury to $HG(6^3P_1)$ by $CO(a^3\Pi)$ was determined in a cross-beam experiment by measuring the time-of-flight distribution of both the metastable CO molecules and the mercury 2537-Å emission. For a cross section functional dependence of v^{-n}, n was found to be 0.8 ± 0.1 over the relative velocity range v = 300 to 700 m/s. (auth)

10378 REDUCTION OF THE GLAUBER EXCHANGE AMPLITUDE. Tenney, A.; Yates, A. C. (Indiana Univ., Bloomington). Chem. Phys. Lett.; 17: No. 3, 324-7(1 Dec 1972).

The "post" and "prior" forms of the Glauber exchange amplitude are reduced in a manner consistent with the Bonham-Ochkur expansions. The application is with respect to the hydrogen atom, wherein the resulting reduced amplitude can be completely evaluated in closed form. Results are presented for the elastic scattering of 4.0-Ry electrons and compared with the corresponding close-coupling and Bonham-Ochkur results. The effect of the Glauber modification is seen to be most important for small angles of scattering. (auth)

10379 ENERGY DEPENDENCE OF THE DIFFERENTIAL COLLISION CROSS SECTION FOR HYDROGEN AT THERMAL ENERGIES. Dondi, M. G. (Univ., Genoa); Valbusa, U.; Scoles, G. Chem. Phys. Lett.; 17: No. 1, 137-41(1 Nov 1972).

In a crossed-beam molecular scattering apparatus the energy dependence of the differential collision cross section for hydrogen was measured. Comparisons with cross sections computed from different potentials are presented and discussed. Preliminary conclusions on the shape of the intermolecular potential energy function are reported. (auth)

10380 MEASUREMENT OF ELECTRON LOSS FROM FAST HYDROGEN ATOMS IN THE 2s STATE ON IMPACT WITH Ar, N_2, AND He. Choe, S. S. Fayetteville, AR; Univ. of Arkansas (1972). 83p. University Microfilms Order No. 72-29,708.

Thesis.

Absolute cross sections were measured for electron loss from fast metastable (2s) hydrogen atoms on impact with Ar, N_2, and He targets in the energy range 20 to 120 keV. The measurement technique involved finding the difference in the stripping cross sections from the H(2s) atom and from the ground-state atom. The measured electron-loss cross sections are compared with cross sections calculated by the method of Bates and Walker. The experimental values agree with theory for impact on He and N_2 at all energies within experimental error. The experimental values for impact on Ar agree with theory at the highest energies but theory overestimates the cross sections at the lower energies. Some cross sections were also measured for electron capture into the stable negative ion state by fast H(2s) impact on Ar, N_2, and He. (Diss. Abstr. Int., B)

10381 PHOTON-PARTICLE COINCIDENCE MEASUREMENT OF CHARGE-TRANSFER EXCITATION OF THE N_2^+ FIRST NEGATIVE 3914A BAND BY PROTONS. Wehrenberg, P. J. Seattle; Univ. of Washington (1972). 164p. University Microfilms Order No. 72-28,680.

Thesis.

The cross section for charge-transfer excitation of N_2^+ first negative 3914-Å band by protons was measured using a photon-particle coincidence technique. The target N_2 is collisionally excited to the N_2^+ ($B^2\Sigma_u^+$) state and emits a 3914-Å photon in the (0,0) transition. This photon is detected in coincidence with the scattered particle, a proton or hydrogen atom, allowing separation of the two reactions that contribute to 3914-Å emission, charge transfer with excitation and ionization with excitation. As by-products of the primary charge-transfer excitation measurement, the cross section for charge transfer, the total cross section for 3914-Å emission, and the lifetime of the N_2^+ ($B^2\Sigma_u^+$) state were measured. The apparatus built for this experiment, including accelerator (5 to 65 keV), scattering chamber, single photon detector, particle detector, and a new dc ion source, is described. An absolute calibration of the particle detector for protons and for hydrogen atoms was done. The new result presented here, the cross section for charge-transfer excitation, indicates that charge transfer is the dominant contributor to 3914-Å excitation at energies below 10 keV and that ionization with excitation becomes increasingly important with increasing energy. The by-product measurements agree well with those of other workers. (Diss. Abstr. Int., B)

10382 ELECTRON SCATTERING FROM DIATOMIC MOLECULES IN THE 1st BORN APPROXIMATION, THE EFFECTS OF

MULTIPLE ELASTIC INTRAMOLECULAR SCATTERING IN ELECTRON DIFFRACTION IN THE 2nd BORN APPROXIMATION, AND THE TOTAL INELASTIC CROSS SECTION FOR H_2 WITH COLLISION BY FAST CHARGED PARTICLES. Liu, J. W. Bloomington, IN; Indiana Univ. (1972). 98p. University Microfilms Order No. 72-30,426.

Thesis.

The differential cross sections for electron scattering from the diatomic molecules H_2 and N_2 in the 1st Born approximation, using molecular wave functions, were calculated. The molecular wave functions for H_2 and N_2 were in the form of a Slater determinant(s) with one-electron Slater-type orbitals (STO's). The STO's involved in all two-center integrals, but not one-center, were expanded in Guassian-type orbitals (GTO's). The result of the calculation for H_2, using a configuration-interaction (CI) wave function containing 97% of the binding energy, leads to agreement with existing experimental data. The results for H_2 can be considered as a standard for comparison with experiment, where the molecular potential is treated in the 1st Born approximation, at the 1% accuracy level. For the case of N_2 the double ξ-exponent wave function of Richardson was used. It was found that the scattered intensity of the electron–nuclear bonding charge density is very sensitive to the choice of molecular wave function used. This study represents the most definitive calculation of the two electron effects in the total scattered intensity so far reported. The total result, including both one- and two-electron terms, was found to be in qualitative agreement with experiment. The effects of multiple elastic intramolecular scattering in electron diffraction was studied in the second Born approximation. The first-order triple scattering contribution including the vibrational average was obtained for the ReF_6 molecule. The results were dissected into a sine and cosine contribution both with the periodicity of the Re–F bond length. The cosine contribution was found to be in excellent agreement with the difference between theoretical and experimental reduced molecular intensity curves reported by Jacob and Bartell. A sum rule, due to Inokuti et al., for the Bethe inelastic cross section for fast charged-particle collisions with atoms and molecules was applied to H_2. Using an accurate two-center CI wave function a formula for nonrelativistic incident particles was found. Although the theoretical values are in good agreement with the summed experimental total ionization (including dissociation ionization), total dissociative excitation, and the most important discrete excitation cross sections, an apparent systematic trend suggests one or more of the current experimental total cross sections for electron impact on H_2 may not be accurate. (TSS) (Diss. Abstr. Int., B)

10383 QUANTUM VIBRATIONAL TRANSITION PROBABILITIES IN ATOM–DIATOMIC MOLECULE COLLISIONS: A TRACTABLE THREE-DIMENSIONAL MODEL. Wilson, D. J.; Locker, D. J. (Vanderbilt Univ., Nashville). J. Chem. Phys.; 57: No. 12, 5393-5402(15 Dec 1972).

The method of Cheung and Wilson [J. Chem. Phys., 51: 3448, 4733 (1969)] is applied to the computation of vibrational transition probabilities for collisions of atoms with spherically symmetric oscillators ("breathing spheres") in three dimensions. Effects of the angular momenta associated with rotation of the sphere and with the relative motion of the atom and sphere are taken into account. Takayanagi's modified wave number method [Progr. Theoret. Phys. (Kyoto), 8: 497 (1952); J. Phys. Soc. (Japan), 14: 75 (1959)] is employed to obtain approximations in closed form to the integrals needed. (auth)

10384 STUDY OF EXCITATION TRANSFER IN A FLOWING HELIUM AFTERGLOW PUMPED WITH A TUNEABLE DYE LASER. II. MEASUREMENT OF THE RATE COEFFICIENT FOR THE ROTATIONAL RELAXATION OF $He_2(3p^3\Pi_g)$. Collins, C. B.; Johnson, B. W. (Univ. of Texas, Dallas). J. Chem. Phys.; 57: No. 12, 5317-21(15 Dec 1972).

The rotational relaxation of the $He_2(3p^3\Pi_g)$ state is examined by optically pumping a flowing helium afterglow with a tuneable dye laser. The population of the J = 8 rotational state is enhanced by optically saturating the R_7 component of the transition connecting this state with the metastable $He_2(2s^3\Sigma_u^+)$ molecular state. From the lifetime and yield of the Q_7 component, the rate coefficient for the rotational relaxation via the forbidden $\Delta J = 1$ channel is determined to be of the order of 2×10^{-11} cm^3/s. It is found that this represents about half of the total rate of rotational relaxation in this state. (auth)

10385 STUDY OF EXCITATION TRANSFER IN A FLOWING HELIUM AFTERGLOW PUMPED WITH A TUNEABLE DYE LASER. I. MEASUREMENT OF THE RATE COEFFICIENT FOR SELECTED QUENCHING REACTIONS INVOLVING $He(5^3P)$. Collins, C. B.; Johnson, B. W.; Shaw, M. J. (Univ. of Texas, Dallas). J. Chem. Phys.; 57: No. 12, 5310-16(15 Dec 1972).

A system is described for the measurement of excited-state reaction times in the nanosecond range. A flowing afterglow produces large populations of chemically unstable species and a pulsed, tuneable dye laser is used to selectively pump these into the reacting excited state. The transient fluoroescence from the populations of reactants and end products is used to determine reaction lifetimes and yields. This radiation is collected with a photon counting system that logs arrival times of spectrally dispersed photons with 10-ns resolution. With this system the rate coefficient for the reaction $He(5^3P) + He \rightarrow He_2^+ + e$ has been measured to be 8×10^{-11} cm^3/s. Upper limits on the reactions $He(5^3P) + He \rightarrow He(5^3D) + He$ and $He(5^3P) + e \rightarrow He(5^3D) + e$ were determined to be 8×10^{-15} cm^3/s and 8×10^{-9} cm^3/s, respectively. (auth)

10386 SEMICLASSICAL THREE-DIMENSIONAL MODEL FOR VIBRATIONAL RELAXATION. Soerensen, G. D. B. (Univ. of Copenhagen). J. Chem. Phys.; 57: No. 12, 5241-50(15 Dec 1972).

In a semiclassical three-dimensional treatment of the atom–diatom scattering problem, the intermultiplet transitions are included to infinite order, whereas simultaneous rotational and vibrational transitions are treated to first order. Thus criteria were found for neglect of intermultiplet transitions. With this model three systems were investigated, namely, the He–H_2, the Ar–HCl, and the Ar–O_2 systems. It was found that transitions with change in both vibrational and rotational quantum number were dominant for the vibrational relaxation process in the Ar–HCl case, while they were important for the Ar–O_2 system and negligible for the He–H_2 system. (auth)

10387 CLASSICAL S MATRIX FOR VIBRATIONAL EXCITATION OF H_2 BY COLLISION WITH He IN THREE DIMENSIONS. Doll, J. D.; Miller, W. H. (Univ. of California, Berkeley). J. Chem. Phys.; 57: No. 12, 5019-26(15 Dec 1972).

Complex-valued classical trajectories were computed by direct numerical integration of the equations of motion for three-dimensional collisions of He and H_2, and from such trajectories classical S-matrix elements for transitions between specific rotational–vibrational states of H_2 were constructed. At the collision energies employed (~1 to 2 eV) all vibrationally inelastic transitions are classically forbidden, thus the need for analytically continued, complex-valued trajectories. Comparison with the quantum mechanical calculations of Eastes and Secrest shows excellent agreement between the quantum and uniform semiclassical transition probabilities. Since, however, for three-dimensional collision systems one is seldom concerned with individual S-matrix elements, but rather sums over many of them, an important practical feature is developed, which shows how one can combine the usual Monte Carlo classical treatment of some of the internal degrees of freedom with a semiclassical state-by-state description of others; i.e., one can "quantize" only those degrees of freedom that are highly quantum-like (e.g., vibration). This "partial averaging" approach also greatly simplifies the practical aspects of applying classical S-matrix theory to systems with several internal degrees of freedom. (auth)

10388 IONIZATION OF THE NOBLE GASES BY PROTONS: JESSE EFFECTS AS A FUNCTION OF PRESSURE. Parks, J. E.; Hurst, G. S.; Stewart, T. E.; Weidner, H. L. (Univ. of Kentucky, Lexington). J. Chem. Phys.; 57: No. 12, 5467-74(15 Dec 1972).

A new method was developed to measure W, the ratio of the energy lost by a proton to the number of ion pairs produced when these particles interact with a gas. In this method, protons are Rutherford scattered from a beam by a thin gold foil into a W cell where total gas ionization is measured. The number of protons scattered into the W cell is measured with a silicon surface-barrier detector, and the energy lost to the gas is calculated from stopping-power data. Most of the protons pass through the thin gold foil and enter an emission cell where emission spectra are studied with a vacuum ultraviolet scanning monochromator. At 400 torr for pure gases the following values of W (eV per ion pair) were found for 3.6- MeV protons: He, 45.2 ± 0.9; Ne, 39.3 ± 0.8; Ar, 26.6 ± 0.5; Kr, 23.0 ± 0.5; Xe, 20.5 ± 1.2; N_2, 36.6 ± 0.7. No appreciable pressure dependence was observed for the pure gases. The Jesse effect, which is the increase in ionization observed when impurities are added to certain gases, was studied as a function of concentration and pressure for mixtures of C_2H_4, C_2H_2, and CO_2 with Ar. At small concentrations of C_2H_4 or C_2H_2 the Jesse effect decreases as the total gas pressure increases. These data, along with other facts cited in this paper, tend to confirm an energy-pathways model for argon. Based on a comparison of the data with this model, the values 6.5×10^{-10} and 1.1×10^{-9} cm^3 s^{-1} were deduced for the rate constants for producing the Jesse effect from the $^1P_1$ (1048 Å) resonance state of argon by collisions with C_2H_4 and C_2H_2, respectively. W values were also studied as a function of pressure and concentration for mixtures of Ne, Ar, Kr, and Xe with He. The dependence of W on pressure and concentration was similar to that of argon. (auth)

10389 ADDITIONAL COMMENT ON THE VIBRATIONAL DISTRIBUTION OF N_2^+ B $^2\Sigma$ PRODUCTS FROM Ne^+-N_2 COLLISIONS. Saban, G. H.; Moran, T. F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 57: No. 12, 5622-3(15 Dec 1972).

In answer to comments of Lowe (J. Chem. Phys., 57: 5621 (Dec. 15, 1972)) on a previous paper (J. Chem. Phys., 57: 895 (1972)), it is pointed out that narrow-band interference filters were employed in the assessment of vibrational distributions and approximate band shapes were determined. Studies of excited-state production in Ne^+-N_2 collisions that indicate that lines of Ne I, Ne II, N I, or N II can be ignored are described briefly. (A.G.W.)

10390 COMMENT ON VIBRATIONAL DISTRIBUTION OF N_2^+ B $^2\Sigma$ PRODUCTS FROM Ne^+-N_2 COLLISIONS. Lowe, R. P. (Univ. of Western Ontario, London). J. Chem. Phys.; 57: No. 12, 5621-2(15 Dec 1972).

A recent paper by Saban and Moran (J. Chem. Phys., 57: 895 (1972)) is criticized on two counts: (1) a system of broad-band filters is not adequate for determining the vibrational distributions, and (2) the possible presence of lines of Ne I, Ne II, N I, or N II cannot be ignored. It is concluded that the vibrational population distributions reported in the above-mentioned paper are invalid for these reasons. (A.G.W.)

10391 INTERMOLECULAR POTENTIALS FROM CROSSED BEAM DIFFERENTIAL ELASTIC SCATTERING MEASUREMENTS. VII. para-H_2 + para-H_2. Farrar, J. M.; Lee, Y. T. (Univ. of Chicago). J. Chem. Phys.; 57: No. 12, 5492-7(15 Dec 1972).

The differential elastic scattering cross section for para-H_2 + para-H_2 was measured at a collision energy of 2.71×10^{-14} erg. Oscillations due to nuclear symmetry were observed in the angular distribution. The data were fit to a spherically symmetric multiparameter potential form giving a well depth $\epsilon/k = 34.8$°K, $r_m = 3.49$ Å. This potential is closer to those obtained from the total elastic scattering cross section by Gengenback and Toennies and from differential cross sections by Dondi, Valbusa, and Scoles than to those derived from bulk properties and early valence-bond calculations. The position of the bound vibrational level has been computed and is found 2.0 cm^{-1} below the continuum. (auth)

10392 MEASUREMENT OF TOTAL INELASTIC CROSS SECTIONS FOR ELECTRON IMPACT IN N_2 AND CO_2. Spence, D.; Mauer, J. L.; Schulz, G. J. (Yale Univ., New Haven). J. Chem. Phys.; 57: No. 12, 5516-21(15 Dec 1972).

The trapped-electron method was used to study the total inelastic cross sections for electron impact in N_2 and CO_2 in the energy region of the low-lying compound states. These compound states are centered energetically at about 2.5 and 3.8 eV above the ground state of N_2 and CO_2, respectively. The measurement gives the total cross section for the excitation of vibrational states that lie above about 1 eV. A reasonable extrapolation gives an indication of the total cross section for excitation of vibrational states at 2.5 eV in N_2 and 3.8 eV in CO_2. For N_2, the value of 6.0×10^{-16} cm^2 is in excellent agreement with the analysis of the swarm data by Engelhardt, Phelps, and Risk. For CO_2 the total inelastic cross section in the region of 3.8 eV is 8.3×10^{-16} cm^2, almost an order of magnitude larger than the previously published value. (auth)

10393 COLLISIONAL IONIZATION OF HELIUM BY 250 eV ELECTRON: EXPERIMENTS WITH COMPLETELY DETERMINED KINEMATICS. Ehrhardt, H.; Hesselbacher, K. H.; Jung, K.; Schulz, M.; Willmann, K. (Trier-Kaiserlautern Univ., Kaiserlautern, Ger.). J. Phys., B (London); 5: No. 11, 2107-16 (Nov 1972).

Measurements of angular correlations between scattered and ejected electrons are presented for electron-impact ionization of helium for the impact energy $E_0 = 256.5$ eV. The two outgoing electrons are measured in coincidence. The fast electrons are detected at fixed angles ($\leq 8°$). The angular distribution of the corresponding slow electrons consists of two maxima (approximately at $-60°$ and $+120°$) in opposite directions and zeros in between. Intensity ratios of the two maxima and their angular positions are determined for different values of the energy and the scattering angle of the fast electrons. The experimental results are compared with several approximations, in which the free electrons are described by plane and/or Coulomb waves. The influence of exchange scattering and of the electron–nucleus interaction is investigated. (auth)

10394 SPIN POLARIZATION AND DIFFERENTIAL CROSS SECTIONS IN THE ELASTIC SCATTERING OF ELECTRONS BY ALKALI METAL ATOMS. Karule, E. (Inst. of Physics, Riga). J. Phys., B (London); 5: No. 11, 2051-60(Nov 1972).

The spin polarization, depolarization ratio, and differential cross sections are calculated for the elastic scattering of electrons by lithium, sodium, potassium, and cesium atoms for the electron impact energies below the excitation threshold. The phase shifts evaluated in the two-state close-coupling approximation (Karule 1965) are used throughout. (auth)

10395 USE OF SECOND ORDER POTENTIALS IN THE THEORY OF THE SCATTERING OF CHARGED PARTICLE BY ATOMS. 3. A FOUR-CHANNEL APPROXIMATION FOR ELECTRON AND PROTON SCATTERING BY HYDROGEN ATOMS. Sullivan, J.; Coleman, J. P.; Bransden, B. H. (Durham Univ., Eng.). J. Phys., B (London); 5: No. 11, 2061-5(Nov 1972).

The method of Bransden and Coleman (J. Phys., B (London), 5: 537-45 (1972)) is applied to scattering by hydrogen atoms in a four-channel approximation in which the 1s, 2s, and 2p states are explicitly included. Results are given for 1s–2s and 1s–2p excitation by electrons and protons. (auth)

10396 INELASTIC CROSS SECTIONS OF EXCITED MOLECULES. 3. ABSOLUTE CROSS SECTIONS FOR ROTATIONAL AND VIBRATIONAL TRANSITIONS IN THE $Na_2(B^1\Pi_u)$ STATE. Bergmann, K. (Univ., Freiburg i. B.); Demtroeder, W. J. Phys., B (London); 5: No. 11, 2098-2106(Nov 1972).

Collision-induced rotational and vibrational energy transfer in electronically excited sodium molecules was investigated by laser-induced fluorescence. As collision partners all rare gases were used as well as H_2, HD, D_2, N_2, and CH_4. The measurements were performed in a glass cell at 600°K and at foreign gas pressures less than or equal to 1 torr. Absolute values of the rotational cross section are given for angular momentum transfer from $|\Delta J| = 1$ up to $|\Delta J| = 6$ for various specified levels in the $Na_2(B^1\Pi_u)$ state with rotational quantum numbers between $J' = 12$ and $J' = 99$. The total cross section for rotational energy transfer is of the order of 100 Å^2. It is nearly independent of J' and the vibrational quantum number v'. The total vibrational cross section is about 10 Å^2 or less. (auth)

10397 EXPERIMENTAL TECHNIQUE FOR THE DETERMINATION OF THE ELECTRON COLLISION CROSS SECTIONS FOR MOMENTUM TRANSFER OF ALKALI METALS AT LOW ELECTRON ENERGIES Beynon, J. D. E.; Brooker, P. G. (Univ. of Southampton, Eng.).

A means of determining with high accuracy the electron-collision cross sections for momentum transfer of alkali metals at electron energies ~0.1 to 0.3 eV is described. The technique takes advantage of the fact that, at such low energies, the collision cross section of argon is approximately three orders of magnitude less than that of the alkali metals. Argon at atmospheric pressure is "seeded" with 1 or 2% of the appropriate alkali metal vapor and the mixture heated in a furnace to 1000 to 2000°K. A plasma is formed in which virtually all the electrons are produced by ionization of the alkali metal, and in which the argon atoms play an almost insignificant role in the electron scattering processes. The electrical conductivity of the plasma is therefore almost totally a function of the alkali metal seed, the argon playing a purely passive role. The conductivity of the plasma is accurately measured using an electrode system incorporating a guard ring and having facility for varying the electrode separation. From a knowledge of the plasma temperature, the electron density can be deduced using Saha's equation; knowing the electron density and the plasma conductivity, the electron collision frequency can be calculated. The collision cross section for momentum transfer of the alkali metal can then be deduced if the partial pressures of the seed and argon are known. Results are quoted for cesium and sodium; in each case the estimated accuracy is better than 10%. (auth)

10398 COLLISIONAL QUENCHING OF METASTABLE HYDROGEN ATOMS. Kass, R. S. Ann Arbor, MI; Univ. of Michigan (1972). 62p. University Microfilms Order 72-29,108.

Thesis.

Measurements of the collisional quenching (depopulation) of the 2S state of atomic hydrogen by helium, neon, argon, and krypton were made. The energy range was in the thermal region ($v \sim 10^6$ cm/s). The cross sections were determined by measuring the attenuation of a beam of H(2S) atoms in passing through targets of the various gases. Time-of-flight techniques were used to measure the velocity dependence of the cross sections. For an incident H(2S) velocity $\approx 1 \times 10^6$ cm/s, the measured cross sections, which include corrections for the effective length of the scattering region and the velocity distributions of the target particles, are: σ(helium) = 81 ± 12 Å^2/atom; σ(neon) = 80 ± 12 Å^2/atom; σ(argon) = 91 ± 14 Å^2/atom; σ(krypton) = 108 ± 16 Å^2/atom. The results for helium are 10 to 15% higher than theoretical results obtained by Slocomb, Miller, and Schaefer and 20 to 25% higher than a calculation by Byron and Gersten using a pseudopotential method. (Diss. Abstr. Int., B)

10399 ENERGY AND ANGULAR DISTRIBUTIONS OF SCATTERED AND EJECTED ELECTRONS PRODUCED BY 50- TO 800-eV ELECTRONS IN HELIUM. Crooks, G. B. Lincoln, NE; Univ. of Nebraska (1972). 150p. University Microfilms Order No. 72-27,387.

Thesis.

The absolute elastic cross sections, differential in angle, for electrons of energy 50, 100, 200, 400, and 800 eV and the absolute excitation cross sections, differential in angle, of the n = 2 states of helium at incident energies of 50 and 100 eV were measured. The absolute cross sections, differential in energy and angle, of the secondary electrons ejected and scattered by helium at incident energies of 50, 100, 200, and 400 eV were also measured. The angular range of the data was 10° to 150°. The electrons scattered and ejected by the static target gas, at a pressure of 1 millitorr, were energy-analyzed by a parallel-plate analyzer with a resolution of 0.35%. The data were placed on an absolute basis by measurement of the physical parameters of the experiment. No normalization to prior experimental or theoretical results was used. The agreement of the present elastic and excitation cross sections with earlier experimental results is good, but the secondary electron cross sections disagree with recent results. Plane-wave calculations that include distortion are in agreement with the experimental data for elastic scattering, but are inadequate for predicting the inelastic cross sections. Distorted-wave calculations are successful in predicting the shape and magnitude of the 2^1P excitation cross sections, but have not yet been calculated for the remaining states. The integrated and total cross sections are calculated from the data and compared with earlier experimental results and theoretical calculations. (Diss. Abstr. Int., B)

10400 CALCULATION OF THE ENERGY AND WIDTH OF THE LOWEST RESONANCE IN e–H SCATTERING. Kuchinskii, V. V.; Rudakov, V. S. Vestn. Leningrad. Univ., No. 16, Fiz. Khim.; No. 3, 35-8(Aug 1971). (In Russian).

The resonant scattering of electrons by the hydrogen atom was considered. The saddle point in the region of complex energies corresponding to the lowest resonance in e + H scattering was calculated with the application of the Zigert definition of resonance. (auth)

10401 CHARGE TRANSFER SCATTERING AT HIGH ENERGIES. Das, J. N. (University Coll. of Science, Calcutta). Lett. Nuovo Cim.; 5: No. 3, 281-4(16 Sep 1972).

A method based on a many-particle theory for rearrangement collisions, recently proposed by the author from the standpoint of field theory, is applied to the process $H^+ + H(1s) \rightarrow H(1s) + H^+$. The asymptotic expression obtained for the cross section is expected not to be far from the correct high-energy form. (A.G.W.)

10402 $He–D_2$ TOTAL SCATTERING CROSS SECTIONS IN THE VELOCITY RANGE 760 TO 2600 m/s. Lilenfeld, H. V.; Kinsey, J. L.; Lang, N. C.; Parks, E. K. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 57: No. 11, 4593-8 (1 Dec 1972).

Measurements of the total scattering cross section Q for $He - D_2$ are reported over a range 760 m/s $\leq v_r \leq$ 2600 m/s in the relative speed. The data were fit with a piecewise continuous potential that also gives a good fit to the diffusion coefficients, has the theoretical C_6 coefficient, and joins smoothly with the short range a priori computed potential. (auth)

10403 ELECTRON EXCITATION CROSS SECTIONS FOR Li (2s → 2p, 2s → 3p), Na (3s → 4p), Mg (3p → 4s), K (4s → 4p), AND Ca (4s → 4p). Simsic, P.; Williamson, W. Jr. (Univ. of Toledo). J. Chem. Phys.; 57: No. 11, 4617-19(1 Dec 1972).

Electron excitation cross sections using the Born approximation are given. Two types of Slater wave functions were used, and the results are compared with other theoretical calculations and experimental data where available. (auth)

10404 TOTAL CROSS SECTIONS FOR FORMATION OF IONS FROM CsBr BY COLLISION WITH Ar, Xe, AND NaBr(Ar). Piper, L. G.; Hellemans, L.; Sloan, J.; Ross, J. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 57: No. 11, 4742-51(1 Dec 1972).

Measurements were made by cross-beam techniques on the absolute total cross section Q for formation of ions from CsBr in collisions with Ar and Xe, and relative total cross section for NaBr with Ar, in a range of relative kinetic energies (Xe: 12 to 120 eV; Ar: 20 to 125 eV). The absolute cross sections obtained for CsBr, with estimates of accuracy, are 5.0 ± 1.2 Å² for Ar and 12.6 ± 2.7 Å² for Xe at a relative kinetic energy of 46 eV. The energy dependence of the cross sections follows closely that predicted by the simple reaction model of hard spheres. A fit of this model to the measurements leads to estimates of threshold energies. Measurements were also made on a crude energy analysis of the ions formed. About half the ions of either sign have laboratory energies below 5 eV and the remainder are distributed continuously over larger energies up to the maximum. Negative ions have somewhat lower energies than positive ones. The results are consistent with a knockout model of collisional dissociation to ions, with a preference for dissociation by collision of the rare gas atom with the heavy (positive) end of the molecule. (auth)

10405 CLOSE-COUPLED CALCULATIONS OF ELECTRON–HYDROGEN-ATOM SCATTERING USING A NONITERATIVE INTEGRAL-EQUATION TECHNIQUE. Knirk, D. L. (Rice Univ., Houston, TX); Hayes, E. F.; Kouri, D. J. J. Chem. Phys.; 57: No. 11, 4770-81(1 Dec 1972).

A noniterative integral-equation approach to electron–hydrogen-atom scattering, including exchange, was developed for the case in which all available channels are open. The technique was implemented on a computer for the calculation of cross sections in the 1s–2s strong-coupling exchange approximation and the 1s–2s–2p close-coupling exchange approximation. The results of these calculations were found to be in good agreement with those obtained by the iterative solution of the differential equations. The merits of the noniterative integral-equation technique are compared with other computational schemes for obtaining scattering information. (auth)

10406 METHOD FOR TREATING LONG-RANGE INTERACTIONS IN NONITERATIVE INTEGRAL-EQUATION FORMALISM: APPLICATION TO ELECTRON–HYDROGEN-ATOM SCATTERING. Knirk, D. L. (Rice Univ., Houston, TX). J. Chem. Phys.; 57: No. 11, 4782-8(1 Dec 1972).

It is shown that equations furnished by the noniterative integral-equation method can be used to construct a procedure for including the effects of long-range potential "tails" into a calculation in which the potential has been truncated at r_N. In particular, sets of integrals that determine the R matrix may be treated as vectors, and a certain matrix Ω applied to these vectors has the effect of "projecting" their values at r_N over the potential tail to give corrected values. The Ω matrix, actually an infinite series, carries the iterative structure of the scattering equations and hence formally resembles a Born series development of the integrals involved. A two-term approximation Ω_1 is considered, and explicit expressions are derived for a potential of the form $V_{ij} = \Sigma_\lambda C_{ij\lambda} r^{-\lambda-1}$. This approximation is applied to the long-range r^{-2} and r^{-3} potential terms in the close-coupled calculations of electron–hydrogen-atom scattering and found to give very good results. (auth)

10407 AB INITIO AND SEMI-EMPIRICAL CALCULATIONS OF THE STATIC POTENTIAL FOR ELECTRON SCATTERING OFF THE NITROGEN MOLECULE. Truhlar, D. G. (Univ. of Minnesota, Minneapolis); Van-Catledge, F. A.; Dunning, T. H. J. Chem. Phys.; 57: No. 11, 4788-99(1 Dec 1972).

Six calculations, three ab initio and three semiempirical, are presented for the static potential (i.e., the interaction potential energy of an electron with the unperturbed charge distribution) of a nitrogen molecule. The ab initio calculations are Hartree- Fock calculations using contracted Gaussian basis sets capable of yielding wave functions (1) near the Hartree–Fock limit, (2) near the sp limit, and (3) at the minimum basis set level. The semiempirical calculations are all within the INDO formalism. It is found that the inclusion of d functions in the ab initio calculations is necessary for an accurate description of the anisotropy of the potential. It is also found that the INDO calculations give the correct form of the potential at small electron–molecule separation distances but are poor at large distances. (auth)

10408 LIMITING FORM OF THE EFFECTIVE POTENTIAL FOR ELECTRON SCATTERING. Huo, W. M. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys.; 57: No. 11, 4800-13(1 Dec 1972).

In a previous article [J. Chem. Phys., 56: 3468 (1972)], an effective potential $\tilde{V}_{f0}$ for direct scattering is defined such that its Fourier transform, multiplied by $-(2\pi)^{-1}$, gives the scattering amplitude. Here the behavior of V_{f0} at the limit $q \rightarrow 0$ is studied, with q the distance between the incident electron and the scattering center. It is found that the limiting form of $\tilde{V}_{f0}$ is expressible by an ascending series, the first term being a q^{-1} term. The coefficient of the constant term is also derived. The applicability of the Born approximation under a number of limiting conditions is considered by means of $\tilde{V}_{f0}$. For inelastic scattering, it is found that, at a fixed incident energy, deviations from the Born approximation will be observed if the momentum transfer is increased. At a fixed scattering angle, deviations from the Born approximation will also be observed if the energy is increased. However, at a fixed momentum transfer, the Born limit will be approached with increasing energy. A number of calculations on both elastic and inelastic scattering are studied in view of the

present results. The derivation in this paper assumes an atomic target but extension to the molecular case is straightforward. (auth)

10409 ABSOLUTE TOTAL SCATTERING CROSS SECTIONS FOR ^{7}Li ON He, Ne, Kr, AND Xe. Dehmer, P.; Wharton, L. (Univ. of Chicago). J. Chem. Phys.; 57: No. 11, 4821-35(1 Dec 1972).

Absolute total scattering cross sections were measured for the systems Li–He, Li–Ne, Li–Kr, and Li–Xe over a range of primary beam velocities of 0.75 to 4.75 × 10^5 cm/s corresponding to a range of kinetic energies of 0.04 to 0.33 eV for Li–He to 0.02 to 0.79 eV for Li–Xe. The standard deviations of the cross sections were less than 1.2% of the observed cross section and the maximum systematic errors were between −0.3% and +1.4%. The data were deconvoluted for the effect of target motion and were statistically smoothed. The smoothed data had a standard deviation of 0.2 to 0.4%, which was about 4 times smaller than the standard deviation of the raw data points and which provided a criterion for judging the adequacy of fits for various model potentials. Model potentials with up to 5 variable parameters were fit to the smoothed cross sections by a least-squares method. For Li–Kr and Li–Xe 4 potential parameters were determined simultaneously. These experiments were most sensitive to the potential value over a range of limiting impact parameters. For Li–Kr and Li–Xe this range was 6.5 to 9.2 Å and 7.8 to 9.7 Å, respectively, and in this region the potential was determined to an accuracy of 3 to 4%, with the error arising primarily from systematic errors in the measurement of the cross section. (auth)

10410 THEORY OF SEMICLASSICAL TRANSITION PROBABILITIES FOR INELASTIC AND REACTIVE COLLISIONS. V. UNIFORM APPROXIMATION IN MULTIDIMENSIONAL SYSTEMS. Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys.; 57: No. 11, 4903-9(1 Dec 1972).

An integral semiclassical expression for the S matrix of inelastic and reactive collisions was formulated earlier in this series. In the present paper a uniform approximation for the expression is derived for the case of multidimensional systems. The method is an extension of that employed in Part II for the case of one internal coordinate. The final result is highly symmetrical, thus making some of its properties immediately clear. (auth)

10411 CONVERGENCE OF THE HYDROGENIC EXPANSION IN H^+–H SCATTERING. Rapp, D.; Dinwiddie, D. (Univ. of Texas, Dallas). J. Chem. Phys.; 57: No. 11, 4919-27(1 Dec 1972).

Calculations were carried out for the processes $H^+ + H(nl) \rightarrow H(nl) + H^+$ and $H^+ + H(nl) \rightarrow H^+ + H(nl)$ using a two-centered expansion in travelling-wave hydrogen orbitals. New four-state calculations were done with 1s, 2s, $2p_0$ and $2p_1$ states included. When proper account of the asymptotic coupling between states is taken, the cross sections are in close agreement with those of Cheshire, Gallaher, and Taylor, In addition, seven-state calculations were performed by including the 3s, $3p_0$, and $3p_1$ states. A comparison of four- and seven-state results shows that the convergence of the cross sections for the n = 2 states appears to be fairly rapid. (auth)

10412 REACTIVE AND ELASTIC SCATTERING OF IONS ON MOLECULES. Henglein, A. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). J. Phys. Chem.; 76: No. 25, 3883-90(7 Dec 1972).

Angular and energy distributions of product ions from simple ion–molecule reactions $X^+ + D_2 \rightarrow XD^+ + D$, where $X^+ = Ar^+$, Kr^+, or O_2^+, were measured. The results were discussed in terms of three collision models; i.e., spectator stripping, impulsive isotropic scattering, and intermediate complex formation. The properties of protonated molecules XH^+ and of possible intermediates XH_2^+ of the ion–molecule reactions were deduced from experiments on the elastic scattering of H^+ and of H_2^+ on X. The potential curves of molecules XH^+ were obtained with high accuracy if rainbow undulations with fine structure could be observed in the differential scattering cross sections. The data from elastic scattering experiments were used to obtain potential energy level diagrams showing the important parts of the potential energy of ion–molecule reactions along the reaction coordinate. In the case of the reaction $Ar^+ + H_2 \rightarrow ArH^+ + H$, 80 to 90% of the heat of reaction is liberated as internal energy of the product ion upon the approach of the reactants, the rest appearing as translational energy upon the separation of the products. Nearly all of the heat of reaction is liberated as translational energy upon the separation of the products in the case of the reaction $Kr^+ + H_2 \rightarrow KrH^+ + H$. This reaction has an activation energy of about 0.7 eV if it is initiated by the $^2P_{\frac{3}{2}}$ ground state of Kr^+. In the case of the reaction $H_2^+ + H_2 \rightarrow H_3^+ + H$, an impulsive scattering mechanism is proposed at low collision energies, since no indication of a potential well for a long-lived H_4^+ intermediate could be obtained from the elastic scattering experiments. (auth)

10413 SHAPE PARAMETER ANALYSIS OF THE 2s(^{1}S) AUTOIONIZATION STATE EXCITED BY PROTON IMPACT ON HELIUM. Stolterfoht, N.; Ridder, D.; Ziem, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett.; 42A: No. 3, 240-2(4 Dec 1972).

Asymmetric autoionization lines in the electron emission spectra of helium were studied by 100- to 500-keV proton impact. Extreme variation of the line profile parameter was found with varying electron emission angle and proton impact energy. (auth)

10414 STRUCTURE IN THE ENERGY DEPENDENCE OF SLOW ATOM–ION CROSS SECTIONS. Latypov, Z. Z. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1061-8(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1329-38(Jul 1972).

Experimental and theoretical work is reviewed on oscillatory structure in the dependence on collision energy of total cross sections for inelastic atomic collisions. Processes are considered for which the cross-section structure is described by the two-state approximation; processes for which the cross-section structure cannot be represented within the framework of that approximation are also discussed. (auth)

Atomic Theory

Refer also to abstract 11249.

10415 SUPEREXCHANGE MODELS. II. A NEW PARAMETRIZATION. Copland, G. M.; Newman, D. J. (Queen Elizabeth Coll., London). J. Phys., C (London); 5: No. 22, 3253-8(14 Nov 1972).

It is shown that the parametrization of matrix elements involving open-shell states at two centers can be conveniently carried out by the introduction of a new type of tensor operator, which is defined in terms of coupled rotations at both centers. This parametrization gives a particularly simple representation of the simplification that results from the factorizability of the superexchange interaction. (auth)

10416 RELAXATION EFFECTS ON AUGER ENERGIES. Shirley, D. A. (Univ. of California, Berkeley). Chem. Phys. Lett.; 17: No. 3, 312-15(1 Dec 1972).

A hitherto-neglected relaxation-energy effect in the Auger process was found, and an approximate theory for calculating it was developed. The effect ranges from about 6 eV in neon to about 150 eV in fermion. Theoretical KL_1L_1 energies show excellent agreement with experiment. The relaxation term is large enough to affect seriously the analysis of unknown Auger spectra. It appears to have very wide application to Auger spectroscopy. (auth)

10417 UPPER-BOUND PROPERTY OF SECOND DERIVATIVES OF THE ENERGY. Deb, B. M. (Indian Inst. of Tech., Bombay). Chem. Phys. Lett.; 17: No. 1, 78-9(1 Nov 1972).

An easy alternative proof is provided for the upper bound relation $(\partial^2 E/\partial\lambda^2)\langle\psi|\psi\rangle \leq \langle\psi|\partial^2 H/\partial\lambda^2|\psi\rangle$. Like an earlier proof by Silverman and van Leuven the present approach presupposes the validity of the Hellmann–Feynman theory. (auth)

10418 SEMICLASSICAL APPROXIMATION OF MULTIDIMENSIONAL BOUND STATES. Pechukas, P. (Columbia Univ., New York). J. Chem. Phys.; 57: No. 12, 5577-94(15 Dec 1972).

The WKB theory of bound states is extended to all states of nonseparable systems derived from separable states by transformations that do not destroy the basic nodal structure of wave functions. The quantum and classical mechanics of the semiclassical approximation are discussed, and the relation to other recent work is analyzed. (auth)

10419 TWO-BY-TWO ROTATION METHOD APPLIED TO SELECTED MULTICONFIGURATION WAVE FUNCTIONS. Chang, T. C.; Grein, F. (Univ. of New Brunswick, Fredericton, Can.). J. Chem. Phys.; 57: No. 12, 5270-6(15 Dec 1972).

General expressions are derived for the optimization of orbital coefficients by the two-by-two rotation (2 × 2) method in the case of multiconfiguration (MC) wave functions of pair-excitation type. Computational examples are given for the He and Be atoms. Application to bigger systems is straightforward and simple. The 2 × 2 equations for MC wave functions containing single excitations have to be derived from case to case. As an example, the all-single-excitation wave function for He is considered.

The 2 × 2 method, although straightforward, is rather lengthy. It presented no convergence difficulties. (auth)

10420 SINGLET–TRIPLET CORRECTION IN THE FINE STRUCTURE OF TWO-ELECTRON IONS. Ermolaev, A. M.; Jones, M. (University Coll., London). J. Phys., B (London); 5: No. 11, L225-8(Nov 1972).

Accad et al. (Phys. Rev., 4A: 516-36 (1971)) have calculated the positions of the levels 2^3P_1 and 3^3P_1 in helium-like ions, neglecting matrix elements connecting n^3P_1 and n^1P_1 states. It is shown that inclusion of these matrix elements gives a considerable improvement in the theoretical fine structure intervals. (auth)

10421 PARTICLE SCATTERING BY TWO LEVEL ATOMS IN A STRONG RADIATION FIELD. Hahn, L.; Hertel, I. V. (Trier-Kaiserslautern Univ., Kaiserslautern, Ger.). J. Phys., B (London); 5: No. 11, 1995-2015(Nov 1972).

A set of coupled equations for particle scattering by a two-level atom in a strong near-resonant radiation field is derived from the time-dependent Schrödinger equation. This set of equations is discussed in a first- and second-order approximation. The result can be visualized in terms of a scheme in which the two well-separated (nondegenerate) atomic states split, each into two energy levels. The splitting depends on the strength of the field and on the difference between the resonance frequency and the frequency of the incident light and is typically a few meV. In this scheme all possible elastic, quasi-elastic, inelastic, and superelastic transitions between the four levels can be induced by collision processes. In addition, multiphoton processes may occur if the scattered particle remains long enough in the interaction region. Estimates of the two-photon gain process for electron and heavy-particle scattering by sodium atoms in a dye laser field are given. It is suggested that the superelastic processes may play an important role in laser-induced gas breakdown, even if the laser frequency does not coincide with any atomic transition. Spontaneous emission of atoms in laser fields is also treated. The results are similar to the particle scattering processes. (auth)

10422 EFFECTIVE CHARGES OF CLOSED SHELLS FOR HEAVY IONS AND ATOMS. Pavinskii, P. P.; Sherstyuk, A. I. Vestn. Leningrad. Univ., No. 4, Fiz., Khim.; No. 1, 155-7(Feb 1972). (In Russian).

Numerical values of the effective nuclear charges are tabulated for l shells of atoms and ions having eleven and twelve closed shells of electrons. (auth)

10423 SUBSTITUTION OF VARIABLES FOR THE SOLUTION OF A SYSTEM OF HARTREE–FOCK EQUATIONS. Gataullin, R.; Arifov, P. U. (Inst. of Electronics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 2, 29-30(1971). (In Russian).

The solution to a system of Hartree–Fock integrodifferential equations was found to yield a sufficiently precise approximation for the determination of wave functions and special energy values of many-electron systems. Certain steps in the development were modified by the introduction of given variables. (K.S.W.)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

10424 EFFECT OF COMPRESSIBILITY ON THE STABILITY OF A VORTEX SHEET IN AN IDEAL MAGNETOFLUID. Duhau, S.; Gratton, J. (Univ., Buenos Aires). Phys. Fluids; 16: No. 1, 150-2(Jan 1973).

The hydromagnetic stability of a vortex sheet with respect to all modulations is examined. A domain of absolute stability not previously noted is found for high compressibility. Stability criteria are given. Onset of instability is related to radiation of hydromagnetic waves. (auth)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

10425 (CONF-720219) PROCEEDINGS OF THE TRIANGLE SEMINAR, BUDAPEST, 9–11 FEBRUARY 1972. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 192p.

Separate abstracts were prepared for the 10 papers presented. (W.H.K.)

For abstracts of individual papers see: 9730, 9731, 10451–10453, 10474–10477, and 10604.

Electromagnetic

10426 (CONF-710974–2) EXPERIMENTS ON DEEP INELASTIC SCATTERING. (1 CHANNEL MEASUREMENT). Drees, J. (Bonn Univ. (West Germany). Physikalisches Institut). 1971. 92p. (In German). Dep. NTIS (U. S. Sales Only).

From Autumn conference on high energy physics; Hamburg, Germany (13 Sep 1971).

The principles of inelastic electron-nucleon scattering are outlined in some detail. The detection apparatus used in the experiments is described. The radiative corrections are derived. The results of the measurements in inelastic electron-proton and electron-deuteron scattering are reported and compared with those of inelastic muon scattering. The relation to other processes and especially inelastic neutrino scattering is discussed. (J.S.R.)

10427 (DESY–72/51) SINGLE PHOTOPRODUCTION OF NEUTRAL π MESONS ON DEUTERIUM IN THE FORWARD DIRECTION AT 4 GeV. Braunschweig, W.; Dinter, H.; Erlewein, W.; Frese, H.; Luebelsmeyer, K.; Meyer-Wachsmuth, H.; Morehouse, C. C.; Schmitz, D.; Schultz von Dratzig, A.; Wessels, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 18p. Dep. NTIS (U. S. Sales Only).

The ratio $R = \{d\sigma/dt[\gamma d \rightarrow (\pi^0 n)p]\}/\{d\sigma/dt[\gamma d \rightarrow (\pi^0 p)n]\}$ was measured at the Deutsches Elektronen-Synchrotron DESY, Hamburg at a mean photon energy of 4.0 GeV in the four-momentum transfer range between $t = -0.2$ (GeV/c)^2 and $t = -1.2$ (GeV/c)^2 in steps of approximately 0.08 (GeV/c)^2. The ratio R is less than 1 up to $t = -0.9$ (GeV/c)^2 and shows a broad minimum around $t = -0.6$ (GeV/c)^2. Corrections for nuclear effects in the deuterium were not applied but are shown to be small. (auth)

10428 (DESY–72/52) SINGLE PHOTOPRODUCTION OF NEUTRAL π MESONS ON HYDROGEN IN THE FORWARD DIRECTION AT 4 GeV. Braunschweig, W.; Erlewein, W.; Frese, H.; Luebelsmeyer, K.; Meyer-Wachsmuth, H.; Schmitz, D.; Schultz von Dratzig, A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 13p. Dep. NTIS (U. S. Sales Only).

The differential cross section of the reaction $\gamma + p \rightarrow \pi^0 + p$ was measured at the Deutsches Elektronen Synchrotron DESY, Hamburg, at a mean photon energy of 4.0 GeV in the four momentum transfer range between $t = -0.2$ (GeV/c)^2 and $t = -1.2$ (GeV/c)^2 in steps of approximately 0.08 (GeV/c)^2. The experiment was carried out in connection with the measurements of the photoproduction of π^0 mesons on deuterium. The contributions arising from background reactions are discussed in detail. (auth)

10429 PROTON COMPTON SCATTERING BETWEEN 650 MeV AND 1350 MeV. Barton, J. S.; Booth, P. S. L.; Carroll, L. J.; (and others) (Univ. of Liverpool). Phys. Lett.; 42B: No. 2, 297-300(27 Nov 1972).

Compton scattering from protons was measured between 650 MeV and 1350 MeV for angles between 60° and 140° CM. (auth)

10430 ELECTRIC DIPOLE MOMENT OF THE NEUTRON. Golub, R.; Pendlebury, J. M. (Univ. of Sussex, Brighton, Eng.). Contemp. Phys.; 13: No. 6, 519-58(Nov 1972).

There are seemingly compelling reasons for expecting the laws of physics to be unchanged under various symmetry transformations. However, during the last fifteen years it has been discovered that many of these symmetries are in fact broken. The search for the electric dipole moment of the neutron has already made, and will continue to make, an important contribution to the understanding of this fascinating and fundamental problem. The experimental limits of sensitivity can be understood in terms of the Heisenberg uncertainty principle and the achievable limits for such things as the electric field strengths and observation times in various systems. The two experimental methods used to date are neutron beam magnetic resonance and crystal diffraction. New methods which have been proposed, such as that using bottled neutrons and further work on existing methods, promise a considerable improvement in sensitivity in the next few years. (auth)

10431 BUTLER–PEARSON MODEL VERIFICATION IN PHOTONUCLEAR REACTIONS WITH PHOTON MAXIMUM ENERGY 1140 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Ganenko, V. B.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 928-33(Jun 1972). (In Russian).

The ratio of deuteron yield at momentum 2P to proton yield at momentum P was measured at angles of 30 and 120° lab. for carbon and lead nuclei, and a dependence of this ratio at P = 350 MeV/c and angles of 60 and 120° was found. The photon maximum energy was 1140 MeV. The experimental results were compared with the Butler–Pearson model predictions. (auth)

10432 RECOIL-PROTON POLARIZATION IN NEUTRAL-PION PHOTOPRODUCTION AND IN PROTON COMPTON SCATTERING. Deutsch, M. (Massachusetts Inst. of Tech., Cambridge); Golub, L.; Kijewski, P.; (and others). Phys. Rev. Lett.; 29: No. 26, 1752-5(25 Dec 1972).

The polarization of the recoil proton in the reactions $\gamma p \rightarrow \pi^0 p$ and $\gamma p \rightarrow \gamma p$ was measured for incident proton energies between 3 and 7 GeV, and t values from -0.2 to -0.65 GeV^2. The polarization in neutral-pion production varies from 0 to -1 over this range. Contrary to expectation, it does not agree completely with the polarized-target asymmetry. (auth)

10433 YAKUTSK EAS COMPLEX ARRAY. Egorov, T. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR); Efimov, N. N.; Kolosov, V. A.; (and others). pp 2059-73 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The array of complex observations of large size EAS constructed near Yakutsk at the latitude of 62°N at 100m above sea level is described. The array is designed for research of energy spectrum, composition and anisotropy of primary cosmic rays in the energy region 10^{17} to 10^{20} eV. The preliminary results of observations started by the first stage of the array were obtained. The EAS Cherenkov light flux is measured at core distance up to 1km. The differential and integral size spectra in interval of 10^7 to 10^9 particles at sea level are determined. The intensity of primary cosmic rays with energy above $2.5 \cdot 10^{17}$ eV is found to be equal $(7{,}0 \pm 4{,}4) \cdot 10^{-15}$ sm^{-2}s^{-1}sr^{-1}. (auth)

10434 ANGULAR DISTRIBUTION AND NUCLEAR INTERACTIONS OF HIGH ENERGY COSMIC MUONS AT LARGE ZENITH ANGLES. Borog, V. V.; Chernyatin, V. K.; Kirillov-Ugryumov, V. G.; (and others) (Inst. of Engineering-Physics, Moscow). pp 2428-35 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The cascade showers produced by high energy muons were registered using an ionization calorimeter. The data based on 10^4 hs of operation time are given. The obtained angular and energy distributions of electromagnetic showers were compared with the calculations based on various assumptions on the muon generation mechanism. The nuclear showers initiated by muons are analyzed to give a classification of the events according to cascade shape in an iron absorber and to obtain the average nuclear cascade. (auth)

10435 PRECISION MEASUREMENTS OF μ_p/μ_N. Petley, B. W.; Morris, K. (National Physical Lab., Teddington, Eng.). Nature (London) Phys. Sci.; 240: No. 100, 83-4(27 Nov 1972).

The results of a precision measurement of the ratio of the magnetic moment of the proton (μ_p) to that of the nuclear magneton (μ_N) are reported. The importance of such a measurement derives from the key role that this ratio plays in the evaluation of values of the fundamental constants of physics, such as the Avogadro number, the ev to amu conversion factor, proton charge to mass ratio, proton to electron mass ratio, and the Faraday. The value of μ_p/μ_N is obtained experimentally by measuring the ratio of the proton spin precision frequency, f_s, to the cyclotron frequency, f_c in the same magnetic field (thus $\mu_p/\mu_N = f_s/f_c$). In

the work described f_s was measured in a spherical water sample by the amplitude bridge method (Rev. Sci. Instruments 20:516 (1949)), and f_c was deduced from measurements of the cyclotron frequencies, in succession, of protons (H^+), hydrogen (H_2^+), deutrated hydrogen (HD^+), deuterium (D_2^+) and helium ($^4He^+$) ions, using a split-plate type of quadrupole omegatron mass spectrometer. Details are given of the method and results obtained. The value obtained for μ_p/μ_N was 2.792775, which is 23.8 ppM higher than the present recommended value, and should give rise to considerable changes in fundamental constants. (UK)

10436 MEASUREMENT OF THE BRANCHING RATIO $\Gamma(X^0 \to \gamma\gamma)/\Gamma(X^0 \to \text{TOTAL})$. Dalpiaz, P.; Frabetti, P. L.; Massam, T.; Navarria, F. L.; Zichichi, A. (CERN, Geneva). Phys. Lett.; 42B: No 3, 377-8(11 Dec 1972).

There were (68 ± 12) events of the type $X^0 \to \gamma\gamma$ yielding the following branching ratio: $\Gamma(X^0 \to \gamma\gamma)/\Gamma(X^0 \to \text{total}) = (1.71 \pm 0.33)\%$. (auth)

10437 MEASUREMENT OF RADIATIVE Λ DECAYS. Baggett, M.; Baggett, N.; Eisele, F.; (and others) (Univ. Heidelberg). Phys. Lett.; 42B: No. 3, 379-80(11 Dec 1972).

The radiative decay mode $\Lambda \to p\pi^-\gamma$ was studied in the 81 cm Saclay hydrogen bubble chamber. From 72 radiative Λ decays with stopping pion and proton one obtains for the branching ratio $\Gamma(\Lambda \to p\pi^-\gamma,\ p_{\pi^-}^* < 95\ \text{MeV/c})/\Gamma(\Lambda \to p\pi^-) = (1.32 \pm 0.22) \times 10^{-3}$ which is in good agreement with theoretical predictions. (auth)

10438 SEARCH FOR UNKNOWN SOURCES OF NEUTRINO-LIKE PARTICLES. Rothenberg, A. F. Stanford, CA; Stanford Univ. (1972). 98p. University Microfilms Order No. 72-30,689.

Thesis.

A search was made, looking for new penetrating particles that could be made by a high energy electron beam striking a target. No evidence was found for such particles. There were recorded ~100 events induced by high energy neutrinos. These event rates are consistent with the interpretation that the neutrinos came from the decays of π and K mesons produced in the target. A limit was set on any unknown source of penetrating particles that would interact in the detector: $\sigma_{prod}\, f_\Omega\, \sigma_{int} f_{tr} < 10^{-70}\ cm^4$, where σ_{prod} is the photoproduction cross section on a single proton, f_Ω is the ratio of the production solid angle to the detector's solid angle ($\approx 3 \times 10^{-3}$ sr), σ_{int} is the detectable interaction cross section per nucleon, and f_{tr} is the probability of transmission through the shield. Also a similar limit was set on any unknown source of a massive penetrating particle with a finite lifetime. $\gamma c\tau$ $e^{6 \cdot 5 \times 10^3}\ cm/\gamma c\tau > 2.2 \times 10^{46}\ cm^{-1}\ \sigma_{prod} f_\Omega f_{tr}$. (Diss. Abstr. Int., B)

10439 ω PRODUCTION BY e^+e^- ANNIHILATION. Benaksas, D.; Cosme, C.; Jean-Marie, B.; (and others) (Paris Univ., Orsay, France). Phys. Lett.; 42B: No. 4, 507-10(25 Dec 1972).

A large solid angle detector was used to observe $\pi^+\pi^-\pi^0$ events produced, at the ω energy, by electron-positron collisions in the ORSAY storage ring. From the ω excitation curve $\sigma(e^+e^- \to \omega \to 3\pi) = (1.80 \pm 0.20)\ \mu b$, $\Gamma = (9.1 \pm 0.8)$ MeV was deduced, and with $B(\omega \to \pi^+\pi^-\pi^0) = 0.898 \pm 0.045$ $\Gamma_{e^+e^-} = (0.76 \pm 0.08)$ keV and $g_\omega^2/4\pi = 18.4 \pm 1.8$ were calculated. (auth)

10440 MEASUREMENT OF THE RADIATIVE DECAY MODES OF THE ω AND φ WITH THE ORSAY STORAGE RING. Banaksas, D.; Cosme, G.; Jean-Marie, B.; (and others) (Paris Univ., Orsay, France). Phys. Lett.; 42B: No. 4, 511-14(25 Dec 1972).

With a large solid angle detector, optimized to detect γ rays, the radiative decay modes of the ω and φ, produced by e^+e^- annihilation, were observed. The results are: $\Gamma(\phi \to \eta\gamma)/\Gamma(\phi \to \text{all}) = (2.6 \pm 0.7)\%$, $\Gamma(\phi \to \pi^0\gamma)/\Gamma(\phi \to \text{all}) = (0.25 \pm 0.12)\%$, $\Gamma(\omega \to \pi^0\gamma)/\Gamma(\omega \to \pi^+\pi^-\pi^0) = (10.9 \pm 2.5)\%$, $\Gamma(\omega \to \eta\gamma)/\Gamma(\omega \to \pi^0\gamma) < 27\%$ with 90% of CL, $\Gamma(\omega \to \pi^0\pi^0\gamma)/\Gamma(\omega \to \pi^0\gamma) < 15\%$ with 90% of CL, without ρ^0 contribution for the ω decay modes. (auth)

10441 MULTIPLICITY IN HADRON PRODUCTION BY e^+e^- COLLIDING BEAMS. Ceradini, F. (Univ., Rome); Santonico, R.; Conversi, M.; (and others). Phys. Lett.; 42B: No. 4, 501-3 (25 Dec 1972).

The average multiplitiicies $\langle n_c \rangle$ and $\langle n \rangle$, of charged and charged-plus-neutral pions produced in e^+e^- collisions, were determined for total center-of-mass energies ranging from 1.2 to 2.4 GeV. No appreciable multiplicity variation is observed over this energy range, where the mean values $\langle n_c \rangle = 3.3^{+0.3}_{-0.3}$ and $\langle n \rangle = 4.4^{+0.4}_{-0.4}$ are found. (auth)

Weak

Refer also to abstract 10562.

10442 (JINR-P1-6760) SEARCH FOR $\pi^+ \to e^+ + \nu_e + e^+ + e^-$ DECAY. Korenchenko, S. M.; Kostin, B. F.; Mitsel'makher, G. V.; Nekrasov, K. G.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 4p. (In Russian). Dep. NTIS (U. S. Sales Only).

The search for the $\pi^+ \to e^- + \nu_e + e^+ + e^-$ decay was carried out with the help of a magnetic spark spectrometer. It is found that $W(\pi^+ \to e^- + \nu_e + e^+ + e^-)/W(\pi^+ \to \mu^+ + \nu_\mu) \leq 8.2 \cdot 10^{-9}$ with 90% confidence level. (auth)

10443 (LBL-995) $3\pi^0$ DECAY OF THE K_L^0. Linscott, I. R. (California Univ., Berkeley. Lawrence Berkeley Lab.). Jul 1972. Contract W-7405-eng-48. 101p. Dep. NTIS.

Thesis.

The $3\pi^0$ decay of the K_L^0 offers the opportunity for observing a possible resonant $\pi^0-\pi^0$ interaction. Six shower events from the decay $K_L^0 \to 3\pi^0$ were reconstructed kinematically to obtain the $3\pi^0$ Dalitz plot, using a monoenergetic K_L^0 beam and a nearly 4π solid-angle, lead plate, spark chamber gamma ray detector. The Dalitz plot does not show any resonant structure. Representing the Dalitz position in polar coordinates (r,θ), the matrix element for the decay, expanded to second order, is of the form $M(3\pi^0) = 1 + \alpha r^2$. The radial distribution of these events has a slope $\alpha = 0.05 \pm 0.08$, consistent with a small $\pi^0-\pi^0$ scattering length. (auth)

10444 EXPERIMENTAL STUDY OF THE MATRIX ELEMENT IN THE $K^+ \to \pi^+\pi^0\pi^0$ DECAY. Aubert, B. (Paris Univ., Orsay, France); Heusse, P.; Pascaud, C.; (and others). Nuovo Cim.; 12A: No. 2, 509-21(21 Nov 1972).

Two independent analyses of the decay mode $K^+ \to \pi^+\pi^0\pi^0$ (τ' mode) are presented; the first one only concerns the π^+ meson energy spectrum, while the second one is based on τ' decays for which the kinematics is completely determined. A linear description of the matrix element $M = 1 + a(M_K/M_\pi^2)(2T^+ - T_{max}^+)$ is found to be satisfactory. The value found for a is -0.32 ± 0.02. (auth)

10445 TEST OF SCALING IN MUON–NUCLEON INELASTIC INTERACTIONS AT SMALL FOUR-MOMENTUM TRANSFERS. Jain, P. L.; Malucci, R. D.; Potoczak, M. J. (State Univ. of New York, Buffalo). Lett. Nuovo Cim.; 5: No. 15, 1005-10(9 Dec 1972).

In order to test scaling in the low q^2 range, where it was not previously tested, the structure function is plotted as a function of q^2. The data from two emulsion stacks exposed to 10.1- and 15.8-GeV/c positive and negative muons were used. It is concluded that it is possible that the scaling observed at SLAC represents the effect of a theory which is totally irrelevant at smaller q^2 and that there is no smooth interpolation between the Regge region and the scaling region. (J.F.P.)

10446 GROUPS OF PARALLEL PENETRATING PARTICLES AND THEIR POSSIBLE SOURCES. Bibilashvili, M. F. (Inst. of Physics, Tbilissi, USSR). pp 2408-13 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

It is known that in studies of the muon component at moderate depths to some hundreds of hg/cm^2 most events will be connected with the registration of muons generated "trivially" in decays of pions and kaons. Using the technique of ionization calorimeter suggested previously, three types of events were selected: muons in EAS, direct production of muon pairs by muons, and at last the group of events which may be explained as produced in X process. Evaluation of the X -mass gives the value Mx ≳ Mp. (auth)

10447 TO PROBLEM OF THE MUON GENERATION SCHEME IN ENERGY REGION 10^{11} TO 10^{13} eV. Krasilnikov, D. D.; Skripin, G. V.; Chirkov, N. P.; Shafer, G. V. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). pp 2421-7 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The data of bursts occuring in spherical ionization chambers shielded by 10.5 cm Pb during January 1954 to March 1971 in Yakutsk and Tixie Bay are presented. The integral intensity of the cosmic ray muons arriving from overall upper hemisphere at sea level is obtained as follows: $2.9(10)^{-6}\,(E_\mu/5(10)^{11})^{-2.27\pm0.08}$ $cm^{-2}s^{-1}$ for $3(10)^{11} < E_\mu < 10^{12}$ eV and $1.3(10)^{-8}\,(E_\mu/5(10)^{12})^{-2.28\pm0.09}$ $cm^{-2}s^{-1}$ for $2(10)^{12} < E_\mu < 10^{13}$ eV. Muons with energies to 10^{12} eV are generated predominantly in $\pi-\mu$ -decay processes. Muons are generated also in another process of the type of direct generation starting with energies $E \geq 1.5(10)^{12}$ eV. (auth)

10448 INVESTIGATION OF NUCLEAR INTERACTION OF COSMIC RAYS MUONS UNDERGROUND. Bezrukov, L. B.; Beresnev, V. I.; Ryajskaya, O. J.; Zatsepin, G. T.; Stepanets, L. N. (Lebedev Inst. of Physics, Moscow). pp 2445-52 of 12th

International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The results of investigation of nuclear interaction of cosmic ray muons with NaCl nuclei at a depth of 316 m.w.e. underground are described. Using scintillation apparatus containing neutron scintillation counter the sizes of showers traversing the apparatus and the number of neutrons accompaning the showers are observed simultaneously. The existence of the neutrons in the showers was the criterion of separation of nuclear showers from the electromagnetic ones. The observed spectrum of nuclear showers agrees with the spectrum calculated from the Hand expression if the photonuclear cross section is $\sigma_{\gamma N} = (1.1 \pm 0.2) \cdot 10^{-28}$ cm^2 per nucleon in the energy range from 2.10^{10} eV to 2.10^{11} eV. The muon nuclear energy loss coefficient calculated from the experimental data is $\beta_r = (0.57 \pm 0.11) \cdot 10^{-6}$ g^{-1}cm^2. Nuclear interactions of muons were first discovered by George, E. P. and Evans, J. in 1950, but to date the nuclear losses of high energy muons are not well studied. The results of the accelerator μ-p inelastic scattering experiment at the muon energy of 10 + 14 GeV at the transferred energy up to 7 GeV agree with the following theoretical expression of the differential cross section. $[d^2\sigma/dg^2d\nu = \Gamma_T(\sigma_T + \epsilon\sigma_S)$, $\sigma_T + \epsilon\sigma_S \approx \sigma\gamma p/1 + g^2]$ with $[\Gamma_T = \alpha/2\pi|g^2|\ K/P^2\ (1 - 2\mu^2/|g^2| + 2EE' - 0.5|g^2|/\nu^2 + |g^2|)]$ and $[\epsilon = (2EE' - 0.5|g^2|/\nu^2 + |g^2|)/(1 - 2\mu^2/|g^2| + 2EE' - 0.5|g^2|/\nu^2 + |g^2|)]$. (auth)

10449 MUON–PROTON INELASTIC SCATTERING AT HIGH ENERGY. Braunstein, T. J. Stanford, CA; Stanford Univ. (1972). 123p. University Microfilms Order No. 72-30,598.

Thesis.

Measurements of the differential cross section for the inelastic scattering of 12-GeV/c muons on protons are reported. These measurements cover a kinematic range of $|q^2|$ (the square of the four momentum transferred from the lepton) up to 4.0 (GeV/c)^2 and of muon energy losses (ν) up to 9.0 GeV. Only the scattered muon is observed in an optical spark chamber apparatus. The data are compared to electron-proton inelastic scattering, and analyzed in terms of possible lepton form factors and anomalous interactions. The μ-p inelastic scattering is found to exhibit the same mild $|q^2|$ behavior as does e-p inelastic scattering. No experimentally significant deviation from the predictions of muon-electron universality was found. If the ratio of muon to electron inelastic cross sections is parameterized by the form $(1.0 + |q^2|/\Lambda_D^2)^{-2}$, it is found with 97.7% confidence that $\Lambda_D > 4.1$ GeV/c. The muon-proton cross sections on the average are slightly smaller than the electron-proton cross sections. This observation is not experimentally significant because such a difference might be caused by systematic errors; but this observation is used to speculate as to the most fruitful direction for future experiments. (Diss. Abstr. Int., B)

Strong (Baryon-induced)

Refer also to abstracts 10109, 10114, 10630, and 10645.

10450 (CERN–72-17, pp 55-123) PHOTON AND HADRON INTERACTIONS IN NUCLEI. Gottfried, K. (CERN, Geneva, Switzerland). 12 Oct 1972.

The lectures cover high energy particle interactions with nuclei, which explain fundamental interactions; coherent, incoherent, and diffractive processes, multiple scattering theory, nuclear photoprocesses, and processes induced by hadrons. (J.F.P.)

10451 (CONF-720219–, pp 1-26) REVIEW OF THE CERN–TRIESTE COLLABORATION WORK AND IDEAS FOR FUTURE DEVELOPMENTS. Fidecaro, G. (CERN, Geneva, Switzerland). 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

Experimental research on strong interactions in the CERN–Trieste collaboration is reviewed. (J.F.P.)

10452 (CONF-720219–, pp 27-38) EXPERIMENTAL WORK BEING CARRIED OUT IN THE DEPARTMENT OF HIGH ENERGY PHYSICS IN BEOGRAD. Juric, M.; Simonovic, J.; Popov, S.; Adamovic, O.; Todorovic, Z.; Antanasijevic, R.; Sidiqui, A. 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

Nuclear emulsion techniques are used to study K^- reactions for hypernuclei production and Λ binding energy in the hypernucleus, also the ternary fission of uranium-235 induced by thermal neutrons is studied giving a yield of ternary relative to binary fission of $(8 \pm 0.4)(10)^{-5}$. (J.F.P.)

10453 (CONF-720219–, pp 82-93) EXPERIMENTING AT THE INTERSECTING STORAGE RINGS (ISR) OF CERN. Gottfried, Ch. 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

A proposed experiment at the intersecting storage rings is described. The experimental set up and preliminary calculations are set forth. The interaction $p + p \rightarrow p + N^*$, $N^* \rightarrow n + \pi^+$ will be investigated to determine diffractive dissociation, the energy dependence of the total cross section, the mass spectrum, resonance energy dependence, the shape and resonance dependence of the differential cross section, and the s- and t-channel helicity conservation with angular distributions. (J.F.P.)

10454 DISTRIBUTION IN TRANSVERSE MOMENTUM OF 5 GeV/c SECONDARIES PRODUCED AT 53 GeV IN THE CENTRE OF MASS. Albrow, M. G.; Barber, D. P.; Bogaerts, A.; (and others) (CERN, Geneva). Phys. Lett.; 42B: No. 2, 279-82 (27 Nov 1972).

Data are reported on the distribution in transverse momentum of 5 GeV/c $\pi^\pm$, $K^\pm$, p and $\bar{p}$, produced in proton–proton collisions at 53 GeV center of mass energy at the CERN ISR. At this energy the magnitude and p_T dependence of the invariant cross section appears to be approximately equal to that at 19 GeV accelerator energy (at the same value of the Feynman variable x), for $\pi^\pm$ and K^+ in the range $0.15 < p_T < 0.95$ GeV/c. (auth)

10455 QUASI-NUCLEONIC NUCLEAR INTERACTIONS OF 23-GeV PROTONS IN A NUCLEAR EMULSION IRRADIATED IN A PULSED MAGNETIC FIELD OF 180 kOe. Zhdanov, G. B.; Tret'yakova, M. I.; Chernyavskii, M. M. Proc. (Tr.) P. N. Lebedev Phys. Inst. (USSR) (Engl. Transl.); 46: 158-77(1971).

An emulsion stack (11 layers) was irradiated by a beam of protons with momentum of 24 GeV/c (beam intensity ~10^4cm^{-2}) in a pulsed magnetic field of 180 kOe. The distribution of the interactions (number of charged secondary particles) are represented in a first approximation by a Poisson law with a mean particle number 4.15. The angular distribution of $\pi^\pm$ mesons and protons in pr interactions of low multiplicity ($n \leq 5$) is characterized by distinct forward asymmetry. The mean asymmetry coefficient is 0.28 ± 0.08 for mesons and 0.22 + 0.28) ± 0.12 for protons, with almost the whole energy flux emitted in the direction of the primary proton and neutron. The nature of the energy distributions of mesons and nucleons changes considerably with increase in multiplicity. Mean energy of protons decreases more rapidly than that of mesons. Two-dimensional (angular and momentum) distributions obtained for $\pi^\pm$ mesons agree with data obtained by the electronic method (for a limited range of angles) for $\pi^\pm$ and π^0 mesons. The ratio of the energies transmitted to charged and neutral mesons is near 1.5 to 1. The most effective method of separating interactions of different type is with a Dremin graph of the distributions of the squares of the 4-momenta transmitted between the two groups of particles associated with the protons of the final state. It was also found that there is high probability of distinctly asymmetric excitation of nucleons in peripheral interactions in which one of the nucleons loses on the average about 80% of its energy on meson formation by being excited to the state of an isobar with mass 3.5 ± 0.5 GeV/c^2 and decaying (on the average) to $p + 4\pi$. (F.S.)

10456 PARITY NONCONSERVATION IN PROTON–PROTON ELASTIC SCATTERING. Ghosh, P. K. Ann Arbor, MI; Univ. of Michigan (1972). 101p. University Microfilms Order No. 72-29,062.

Thesis.

Parity violation, predicted and observed in complex nuclei, indicates the existence of a weak parity-nonconserving force of strength ~10^{-6} compared with the strong nuclear force. The effects of parity nonconservation in proton-proton elastic scattering are analyzed. It is found that a measurement of the forward-backward asymmetry in the differential cross section at 90°CM, using a longitudinally polarized incident beam, would provide a direct test of parity nonconservation (PNC) in the nucleon-nucleon interaction. The asymmetry coefficient is found to be ~10^{-6} to ~10^{-8} in the energy range considered ($0 < E_{Lab} \leq$ 200 MeV) for several weak interaction models involving charged as well as neutral currents. For all these models, the asymmetry is biggest (3 to 8×10^{-6}) at $E_{lab} \approx 10$ MeV. However, the asymmetry is zero for the Cabibbo model involving charged currents only. A measurement of the asymmetry would provide a method of distinguishing among the several weak interaction models. The results suggest the feasibility of measuring PNC in the elastic scattering of few nucleon systems at low energies. (Diss. Abstr. Int., B)

10457 REACTION $p + p \rightarrow \gamma$ + ANYTHING AT 205 GeV AND ITS IMPLICATIONS FOR π^0 PRODUCTION. Charlton, G. (Argonne National Lab., IL); Cho, Y.; Derrick, M.; (and others). Phys. Rev. Lett.; 29: No. 26, 1759-62(25 Dec 1972).

From observations of photon conversions into electron pairs in

the 30-in. hydrogen bubble chamber exposed to a 205-GeV proton beam at the National Accelerator Laboratory, topological and differential cross sections were measured for the inclusive reaction $p + p \rightarrow \gamma +$ anything. Comparison with data on the same reaction at the CERN intersecting storage rings suggests that π^0 production in pp collisions has reached a scaling limit by 205 GeV. It is found that for multiplicities up to about 12, the average number of π^0's per inelastic pp collision increases with the number of charged particles produced. (auth)

10458 SMALL-ANGLE ELASTIC PROTON–PROTON SCATTERING FROM 25 TO 200 GeV. Bartenev, V. (State Committee for Utilization of Atomic Energy of the USSR, Moscow); Kuznetsov, A.; Morozov, B.; (and others). Phys. Rev. Lett.; 29: No. 26, 1755-8 (25 Dec 1972).

The differential cross section was measured for small angle p-p scattering from 25 to 200 GeV incident energy and in the momentum transfer range $0.015 < |t| < 0.080$ $(GeV/c)^2$. It is found that the slope of the forward diffraction peak, b(s), increases with energy and can be fitted by the form $b(s) = b_0 + 2\alpha' \ln s$, where $b_0 = 8.3 \pm 1.3$ and $\alpha' = 0.28 \pm 0.13$ $(GeV/c)^{-2}$. Such dependence is compatible with the data existing both at higher and lower energies. Also the energy dependence of the p-p total cross section was obtained in the energy range from 48 to 196 GeV. Within the errors which are ±1.1 mb the total cross section remains constant. (auth)

10459 MEASUREMENT OF THE CHARGED-PARTICLE MULTIPLICITY IN pp COLLISIONS AT 102 GeV/c. Chapman, J. W. (Univ. of Michigan, Ann Arbor); Green, N.; Roe, B. P.; (and others). Phys. Rev. Lett.; 29: No. 25, (18 Dec 1972).

Preliminary results are presented from a sample of ~1200 events obtained from an exposure of the 30-in. Argonne National Laboratory–National Accelerator Laboratory liquid-hydrogen bubble chamber to 102-GeV/c protons. The elastic and total inelastic cross sections are respectively 6.9 ± 1.0 and 32.8 ± 1.1 mb. The parameters of the multiplicity distribution for negative tracks are $\langle n_- \rangle = 2.17 \pm 0.07$, $D_-^2 = \langle n_-^2 \rangle - \langle n_- \rangle^2 = 2.56 \pm 0.12$, and $f_2^- = D_-^2 - \langle n_- \rangle = 0.39 \pm 0.10$. (auth)

10460 RESEARCH INTO PROPERTIES OF HADRONS WITH THE HELP OF MULTI-LAYER PROPORTIONAL COUNTER AT MOUNTAIN-TOP LEVEL. Bashindjahgyan, G. L.; Murzin, V. S.; Sarycheva, L. I.; Sinyov, N. B. (Moscow State Univ.). pp 2211-28 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

Using a multi-layer proportional counter combined with ionization calorimeter it appeared to be possible to distinguish individual pions and protons from the flux of cosmic particles of energy 80 to 400 GeV. At the average energy of 100 GeV, about $\frac{1}{3}$ of charged hadrons were identified as pions. Some characteristics of pion and proton interactions were obtained. (auth)

10461 INVESTIGATION OF SOME CHARACTERISTICS OF HADRONS WITH THE ENERGY ABOVE 1 TeV INTERACTING WITH THE LEAD NUCLEI. Nam, R. A.; Nikolskii, S. I.; Pavlutchenko, V. P.; Yakovlev, V. I. (Lebedev Inst. of Physics, Moscow). pp 2259-72 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

Using the ionization calorimeter the part of energy K_γ transferred to γ-rays in hadron interactions was measured $K_\gamma = 0.25 \pm 0.02$ in the energy range under 5 TeV, and it increases up to $K_\gamma = 0.34 \pm 0.03$ at energy above 10 TeV. Simultaneously, the absorption length of the nuclear cascade (up to a depth ~600 g/cm^2 of lead) decreases from (500 ± 30) g/cm^2 at energy 2 TeV down to (310 ± 20) g/cm^2 at an energy above 10 TeV. Possible interpretation of these effects are discussed. (auth)

10462 STUDY OF HIGH ENERGY INTERACTIONS OF PIONS AND NUCLEONS WITH NUCLEUS AT THE KUM-BEL MOUNTAIN STATIONS. Azimov, S. A.; Abdullaev, A. M.; Beisembaev, R. U.; (and others) (Academy of Sciences, Tashkent, USSR). pp 2273-7 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

The high energy interactions of neutral and charged primary particles with a target nucleus of the energies 2.10^{11} to 10^{12} eV were studied at the "Kum-Bel" Mountain Station, 3200m above sea level. The apparatus consists of wide-gap spark chambers with an effective area of $2m^2$, thin Cherenkov counters. The combination of the Cherenkov total absorption spectrometer with the ionization calorimeter is used to measure the primary energy. The first experimental data on the multiplicity, inelasticity coefficient, and angular distribution of secondary particles are presented. (auth)

10463 SURVEY OF HEAVY PARTICLES AT SEA LEVEL AND MOUNTAIN HEIGHT. Galper, A. M.; Gomozov, V. A.; Kirillov-Ugryumov, V. G.; (and others) (Inst. of Engineering-Physics, Moscow). pp 2317-27 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

The results of a search for nonrelativistic single-charged particles ($\beta < 0.67$) with the mass $M \geq 2Mp$, where Mp is a proton mass, in cosmic rays, were considered. The principle of selection of heavy particles is based on the range of the particle versus its mass at a fixed velocity. Particles are selected as a function of velocity by three Cherenkov counters triggered in an anti-coincidence channel. The instrument includes eight spark chambers allowing one to determine a range of the particles being recorded. To make the selection of heavy particles more reliable, a pulse amplitude of two scintillation counters was determined. The geometry factor of the instrument is 20 cm^2 sterad. The results of measurements performed both at sea level and at mountain height (3,340 m above sea level) are given. (auth)

10464 NUCLEAR INTERACTION IN THE ATMOSPHERE AT ENERGY OF $\sim 5 \times 10^{14}$ eV. Zhadanov, G. B. (Inst. of Space Research, Moscow); Brikker, S. I.; Podgurskaya, A. V.; Poperyekova, L. M. pp 2328-42 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

The installation comprised three photoemulsion layers located under 1, 2, and 3 cm of lead, x-ray films, an ionization calorimeter and a hodoscope. It was in operation during a long time on the mountain Aragatz (a 3250 m altitude). The most energetic nuclear interaction in the atmosphere at the height of 1, 5 + 3 km above the observation level of those recorded by the calorimeter was studied in detail. The height of the interaction was determined by both the age of electron-photon avalanches and the method of γ-quanta pair combinating into π^0-mesons. The products of the interaction (or of two successive interactions) were: nuclear-active component with total energy of ~300 TeV; 2 leading π^0-mesons (3 to 4 γ-quanta) created the electron-photon core of the shower, with energy of ~100 TeV; 28 electron–photon cascades each with energy of ≥0.7 TeV and ~70 TeV in total. The interaction was accompanied by an atmospheric shower with total energy of $\geq 10^{16}$ eV. The characteristic feature of initial interaction is the presence of the large transversal momenta of π^0-mesons (1-2 GeV/c) in the essential fraction of events. (auth)

10465 S-SYSTEM MOVEMENT INFLUENCE OF THE ANGULAR DISTRIBUTION CHARACTERISTICS OF SECONDARY PARTICLES AT HUNDRED GeV ENERGY REGION. Babaev, M. K.; Eremenko, Yu. A.; Lukin, Yu. T.; Takibaev, Z. S. (Inst. of High Energy Physics, Moscow). pp 2343-52 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

The angular distribution of secondary particles is investigated for cosmic hadrons interactions at several hundred GeV registered with a cloud chamber. The carbon target with a thickness of about 0.1 interaction mean free path length was installed inside the cloud chamber and that enabled one to separate the jets induced by charged or neutral primary particles. The primary energy was determined with the help of an ionization calorimeter. The experimental data enabled us to evaluate the parameters of S–system movement (the system of symmetric emission of secondary particles) relative to the CMS. There was made a calculation of asymmetry jets number for one—fireball model with the assumptions that fireball has some velocity distribution in CMS and has nonzero transverse momentum. Besides parameter α, which characterizes asymmetry in CMS relative to the plane perpendicular to the colliding line of interacting particles, there was introduced another analogous parameter β, which is asymmetry measure for azimuth plane. It was shown that using both parameters α and β simultaneously one can get the information about S—system movement not only along the colliding direction, but also about its movement at some angle to this direction. The S—system movement influence on the other angular distribution characteristics, in particular, on the dispersion of angular distribution was investigated. Comparison of calculated and experimental distributions of asym-

metry parameters showed that our experimental data did not contradict the notion of one—fireball generation only at 25 to 50% of events. (auth)

10466 FAMILY OF γ-QUANTA WITH THE ENERGY OF 250 TeV AS AN EXAMPLE OF SUPERHEAVY CLUSTER PRODUCTION WITH MASS ABOUT 7 GeV RELEASED INTO γ-QUANTA. Apanasenko, A. V.; Baradzei, L. T.; Smorodin, Yu. A.; Solopov, E. A. (Lebedev Inst. of Physics, Moscow). pp 2353-61 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A γ-quanta family with the total energy of about 250 TeV was detected in a big emulsion chamber exposed at a pressure of 200 g/cm² on board aircraft. There were 9 γ-quanta with energy above the threshold energy of 0.2 TeV in the family, half of them being born in the nuclear interaction giving origin to the family. The objective methods of altitude evaluation at which interaction takes place and determination of mass and Lorentz-factor system emitting γ-rays are considered. It is shown that the given family cannot be interpreted either as the production of a cluster with mass released into γ-rays of about 1 GeV and by successive cascade multiplication or as successive nuclear interaction. The data have a good interpretation if this family is the result of disintegration of superheavy cluster with the mass about 7 GeV liberated into γ-rays. It is impossible without further calculations to exclude the interpretation as the family of several nuclear interactions of a narrow beam of nucleons originating in the upper layer of the atmosphere after the desintegration of primary nuclei of the type C, N, O. The example of a family with energy of 120 TeV is listed. It can not be the result of decay of the cluster with the mass more than 2 GeV liberated into γ-rays and thus justifies the fact that at energies above 10^{14} eV there is production of heavy clusters. (auth)

10467 MASSES OF THE Ξ HYPERONS. Wilquet, G. (Univ Libre, Brussels); Fliagine, V. B.; Guy, J. G.; (and others). Phys. Lett ; 42B: No. 3, 372-6(11 Dec 1972).

Using a 2.1 GeV/c K^- exposure in a heavy liquid bubble chamber, the masses of the Ξ hyperons were measured to be $M(\Xi^0)$ = 1315.2 ± 0.9 MeV/c² and $M(\Xi^-)$ = 1321.12 ± 0.41 MeV/c². Their mass difference is compared to theoretical predictions. (auth)

10468 MEASUREMENT OF $\bar{p}p \to \pi^+\pi^-$ AND $\bar{p}p \to K^-K^+$ FOR SMALL VALUES OF t AND u AT 3 AND 4 GeV/c. Brabson, A. (Istituto Nazionale di Fisica Nucleare, Padua); Calvelli, G.; Cittolin, S.; (and others). Phys. Lett.; 42B: No. 2, 287-90 (27 Nov 1972).

The differential cross section for $\bar{p}p \to \pi^+\pi^-$, K^+K^- around 0° was measured with good statistics. The data and previous results show that the s-dependence of dσ/dt has a value compatible with the appropriate baryon exchange. The dip at $u \approx -0.15(GeV/c)^2$, expected in $\bar{p}p \to \pi^-\pi^+$ according to some models is not observed. Instead, a break in the slope of dσ/du is seen for $u \approx -0.30\,(GeV/c)^2$ at 4 GeV/c. (auth)

10469 STUDY OF BACKWARD $\bar{p}p$ CHARGE EXCHANGE SCATTERING, 1 TO 3 GeV/c. Storer, J. G. Stony Brook, NY; State Univ. of New York (1972). 117p. University Microfilms Order No. 72-30,469.

Thesis.

The differential cross section for the process $\bar{p}p \to \bar{n}n$ near 180° in the c.m. system. Data are presented for 21 incident momenta between 1.0 and 3.0 GeV/c. The minimum value of the 4-momentum transfer squared (u) for which the differential cross section was measured is $-0.05\ (GeV/c)^2$. The experiment utilized a secondary $\bar{p}$ beam from the AGS at Brookhaven National Laboratory and a liquid hydrogen target. Massive steel-scintillator sandwich type detectors were used to detect the secondary neutrons and antineutrons produced in $\bar{p}p$ charge exchange reactions. Several features of the data are discussed. The $\bar{p}p \to \bar{n}n$ differential cross section exhibits a backward peak at all of the incident momenta studied. The peak becomes steeper with increasing beam momentum. The magnitude of the cross section decreases with increasing beam momentum. The cross section decreases by a factor of 10 from 1 to 3 GeV/c. The $\bar{p}p$ backward charge exchange data are compared with the $\bar{p}p$ backward elastic cross section and, although the errors on the charge exchange data are rather substantial, it appears that the two cross sections are comparable in magnitude. The $\bar{p}p \to \bar{n}n$ cross section is then discussed in terms of direct and exchange channel processes. (Diss. Abstr. Int., B)

10470 EXPERIMENT TO STUDY 10-TeV HADRON INTERACTIONS. Humphreys, D. R. Baton Rouge, LA; Louisiana State Univ. (1972). 39p. University Microfilms Order No. 72-28,354.

Thesis.

An experiment is described which is underway to study the properties of gamma rays emitted from individual interactions of known ultra-high energy (10 TeV). This experiment is being carried out at an altitude of 3.7 km (660 g/cm²) in the Louisiana State University Cosmic Ray Laboratory located near Climax, Colorado. An emulsion chamber of unique design is used to determine the energies and spatial relations of gamma rays emitted in the decay of π^0 mesons originating from individual interactions of ultra-high energy hadrons in a carbon target located above the emulsion chamber. The total energy of an event is determined using an ionization spectrometer having a low-Z (glass) absorber which is about 11 interaction mean free paths deep. Ionization within the spectrometer is sampled every 2 radiation lengths by layers of plastic scintillator which are viewed by photomultipliers. Space and energy resolution within the spectrometer are achieved by using image intensifier cameras that give right-angle stereoscopic photographs of high energy cascades passing through the layers of scintillator. Time resolution with the emulsion chamber is achieved by pulsing the image intensifier cameras as well as neon flash tube hodoscopes when the ionization energy loss within the spectrometer exceeds a threshold value. Soon after the events of interest have occurred, emulsions containing the events are removed for processing the analysis. The pulse height recording system used in the experiment is described in detail. This system can photographically record with one dual-beam oscilloscope the amplitudes of 10 simultaneous photomultiplier pulses over a four-decade dynamic range with an accuracy of ±1.5% over the entire range. The signal processing time is 2.2 μsec. The basic circuit is a logarithmic pulse-height-to-time converter with two triggering levels, requiring twelve transistors per input channel. The dynamic range of the device could be easily extended to six decades, and the two-level technique can be applied to digitized recording systems and pulse height analyzers. The circuit has been found to meet the above specifications over a temperature range from −19 to +38°C. (Diss. Abstr. Int., B)

10471 OBSERVATION OF THE FORBIDDEN DOUBLE CHARGE EXCHANGE REACTION $\bar{p}p \to \bar{\Sigma}^-\Sigma^-$ AT 3.6 GeV/c. Atherton, H. W.; Celnikier, L. M.; French, B. R.; (and others) (CERN, Geneva). Phys. Lett.; 42B: No. 4, 522-6(25 Dec 1972).

Data are presented which firmly establish the existence of the double charge exchange reaction $\bar{p}p \to \bar{\Sigma}^-\Sigma^-$ at 3.6 GeV/c. The forward cross section was found to be (5.9 ± 1.1) μb and the ratio of the "forbidden" to "allowed" forward cross-section is $R = \sigma(\bar{\Sigma}^-\Sigma^-)/\sigma(\bar{\Sigma}^+\Sigma^+) = 0.09 \pm 0.02$. (auth)

10472 AVERAGE CHARGED PARTICLE MULTIPLICITY AND TOPOLOGICAL CROSS SECTIONS IN 50 GeV/c AND 69 GeV/c pp INTERACTIONS. Ammosov, V. V. (Inst. for High Energy Physics, Serpukhov, USSR); Boitsov, V. N.; Ermolov, P. F. Phys. Lett.; 42B: No. 4, 519-21(25 Dec 1972).

In an exposure of the chamber Mirabelle at the Serpukhov accelerator, 1,943 interactions at 50 GeV/c and 8,959 at 69 GeV/c were observed. Topological cross sections and charged multiplicity distributions are presented. The average charged multiplicities found are respectively 5.32 ± 0.13 and 5.89 ± 0.07. (auth)

10473 CHARGED PARTICLE PRODUCTION AT THE CERN ISR AS A FUNCTION OF TRANSVERSE MOMENTUM. Bertin, A. (Univ., Bologna); Capiluppi, P.; D'Agostini-Bruno, M.; (and others). Phys. Lett.; 42B: No. 4, 493-6(25 Dec 1972).

Experimental results are presented on the production of charged particles in inclusive reactions at ISR energies. The data have been taken as function of transverse momentum p_t at the fixed x-values of 0.08, 0.16 and 0.32. The behavior of the p_t-distributions for the different particles is discussed. (auth)

Strong (Meson-induced)

Refer also to abstracts 9747, 10604, and 10611.

10474 (CONF-720219–, pp 39-45) EXPERIMENTAL RESULTS OF THE VIENNA BUBBLE CHAMBER GROUP. Otter, G. 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

The experimental investigation of the K^- + p interaction at high energies by the Vienna bubble chamber group over the past six years is summarized. (J.F.P.)

10475 (CONF-720219–, pp 47-60) CHARGED AND NEUTRAL PARTICLE MULTIPLICITY IN π^-p AND π^-n INTERACTIONS AT 40 GeV/c. Balea, O.; Boldea, O.; Felea, S.; (and others). 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

Data on multiplicity of charged particles and π^0 mesons in π^-p and π^-n interactions at 40 GeV/c are presented. Charged particle

multiplicity distributions are well described by the Wang model I and the empirical formulas of Czyzewski and Rybicki and of Bozoki et al. The average number of π^0's is 2.51 ± 0.06 per inelastic π^-p event and 2.29 ± 0.09 inelastic π^-p event. The average π^0 multiplicity tends to increase with increasing number of charged particles. The results agree with a model which assumes the Czyzewski–Rybicki formula for the distribution of the total particle multiplicity and the isospin independence hypothesis. (auth)

10476 (CONF-720219–, pp 94-8) $\pi^-p \rightarrow$ NEUTRALS AT SERPUKHOV ENERGIES. Leder, G. (High Energy Physics Inst., Vienna, Austria). 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

Proposed experiments for the study of the differential cross sections for the reaction $\pi^- + p \rightarrow \pi^0 + n$ at 20 to 45 GeV/c, and for neutral resonance cross sections and masses in the reaction $\pi^- + p \rightarrow 2\pi^0 + n$ at 25 to 45 MeV/c are described. (J.F.P.)

10477 (CONF-720219–, 129-80) ELASTIC SCATTERING OF 2 AND 4 GeV/c POSITIVE PIONS AND KΣ PRODUCTION ON POLARIZED PROTONS NEAR THE BACKWARD DIRECTION. Penzo, Aldo (CERN, Geneva, Switzerland). 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

A counter and spark chamber experiment to measure polarization in $\pi^+p \rightarrow \pi^+p$ and $\pi^+p \rightarrow K^+\Sigma^+$ at 2 and 4 GeV/c in the backward direction is described, quoting part of the results obtained. The experiment is the work of the CERN–Trieste High-Energy Group. (auth)

10478 (FSU-HEP-72-8-23) STUDY OF HIGH ENERGY π^+ DEUTERIUM EXPERIMENTS. Wilkins, D. P. (Florida State Univ., Tallahassee. High Energy Physics Lab.). Aug. 1972. 59p. Dep. NTIS.

Thesis.

The reactions $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$, $\pi^+d \rightarrow p_s p\pi^+\pi^-$, and $\pi^+d \rightarrow p_s p\pi^+\pi^-\pi^0$ are investigated. All previous work published on these reactions at beam energies greater than 5 GeV are compared, criticized and analyzed. Predictions are made for energy dependent quantities and production mechanisms for these reactions at 15 GeV/c incident π^+ momentum. (auth)

10479 (LBL-1019) HIGH STATISTICS STUDY OF THE REACTION $\pi^-p \rightarrow \pi^0n$ BETWEEN 1.0 AND 2.4 GeV/c. Nelson, J. E. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 111p. Dep. NTIS.

Thesis.

Differential cross sections for the reaction $\pi^-p \rightarrow \pi^0n$ were measured at six incident pion momenta in the region 1.0 to 2.4 GeV/c. The experiment was performed at the Bevatron, using a negative pion beam focused onto a 20-cm liquid hydrogen target. The reaction was identified and measured using the decay of the π^0 into two γ rays. The γ rays were detected by a set of lead-plate spark chambers which surrounded the target, covering about 3.7 π solid angle. The chambers were seven to eight radiation lengths thick to insure high γ ray conversion probability and they covered five sides of a cube, the beam's entrance side being left open. This opening was nearly closed by a set of lead-scintillator sandwich gamma counters. At each momentum a very clean sample of between 2500 and 6500 π^0 events with both γ rays seen in the spark chambers was obtained. The spark chamber geometry was corrected in these events by a Monte Carlo calculation and the corrected sample was fitted with Legendre polynomials. A comparison of the differential cross section with the predictions of phase shift analyses was made. The t-distributions were compared with the predictions of Regge theory. Extrapolated forward cross sections were compared with dispersion calculations. Since the event trigger was on neutral final states the cross sections for $\pi^-p \rightarrow$ neutrals and the reactions $\pi^-p \rightarrow \eta n$, $\pi^0\pi^0n$, $\pi^0\pi^0\pi^0n$ were also obtained. (auth)

10480 (ORO-3509-9) ELEMENTARY PARTICLE PHYSICS. Progress Report, November 1, 1971–October 31, 1972. Lannutti, J. E. (Florida State Univ., Tallahassee). 1972. Contract AT(40-1)-3509. 19p. Dep. NTIS.

Experimental research on strong interactions is summarized. A list of publications is included. (J.F.P.)

10481 (UCLA-10-PA-25-16) ANNUAL PROGRESS REPORT. (California Univ., Los Angeles. Dept. of Physics). Nov 1972. Contract AT(11-1)-Gen-10. 13p. Dep. NTIS.

Experimental research on strong interactions is summarized. A list of publications is included. (J.F.P.)

10482 POSSIBLE EXISTENCE OF A NEW Y* RESONANCE AT 1930 MeV. Dudo, S.; Birman, A.; Goldberg, J.; Weiss, H. (Technion-Israel Inst. of Tech., Haifa). Phys. Rev. Lett.; 29: No. 25, 1695-8(18 Dec 1972).

A new resonant wave with unknown isospin and $J^P = 7/2^-$ ($9/2^-$ not completely excluded) is found to be necessary in order to explain the energy dependence of the higher Legendre polynomial coefficients (A_6, A_7, and A_8) in the expansion of the K^-p elastic scattering differential cross section between 1937 and 1991 MeV. Assignment of this tentative resonance to a $7/2^-$ octet with the known N(2190) and Λ(2100) is found to be reasonably good. (auth)

10483 CUSPS, DIPS, AND RESONANCES. Hoff, G. T. (Univ. of Illinois, Chicago). Phys. Rev. Lett.; 29: No. 25, 1705-8(18 Dec 1972).

Striking regularities in plots of π^+p elastic differential cross-section data at fixed c.m. angles are exhibited, a simple interpretation in terms of strongly correlated resonances is proposed, and further experimental tests of this idea are suggested. A novel and simple method for the determination of resonance energies and total widths based on the proposed model is also pointed out. (auth)

10484 PRODUCTION OF CHARGED A_2 MESONS AT 4 BeV/c. Ankenbrandt, C. M.; Brabson, B. B.; Crittenden, R. R.; (and others) (Indiana Univ., Bloomington). Phys. Rev. Lett.; 29: No. 25, 1688-91(18 Dec 1972).

The mass spectrum of charged A_2 mesons was measured in the reaction $\pi^\pm p \rightarrow pX^\pm$ at 4 BeV/c. More than 3700 events per 5-MeV bin were recorded at the A_2^+ peak. More than 2600 events per 5-Mev bin were recorded at the A_2^- peak. The standard deviation of the experimental resolution function is 3.9 MeV. The A_2^+ and A_2^- mass spectra have shapes compatible with a simple Breit–Wigner resonance on a linear background. (auth)

10485 ENERGETICALLY SELECTED CHARGED AND NEUTRAL PARTICLES IN π^-–N INTERACTIONS AT 60 GeV/c. Orlova, G. I.; Tretjakova, M. I. (Lebedev Inst. of Physics, Moscow). pp 2297-2306 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

In the nuclear emulsions exposed at the Serpukhov accelerator by π^--mesons at 60 GeV/c for π^-–N interactions with the multiplicity of charged particles n = 1–8 the momenta of more than 500 secondaries in a forward hemisphere (in the center-of-mass system) were measured. The characteristics of energetically selected charged particles ($E > 0.3E_0$) and the data concerning the energy fraction taking away by one, two, three, and so forth particles for the events with $\Sigma E\pi\pm \geq 0, FE_0$ are obtained. For the events with n = 1–5 and $\Sigma E\pi_0 \geq 0, bE_0$ data are presented on the characteristics of neutral energetically selected pions and also a spectrum of γ-rays. The characteristics of neutral energetically selected pions coincide with those of the charged ones. (auth)

10486 SPECTRUM OF γ-RAYS FROM COHERENT INTERACTIONS OF π^--MESONS ON PHOTOEMULSION NUCLEI AT 60 GeV/c. Maslennikova, N. V.; Smironova, L. N.; Tretjakova, M. I.; Chernjavskii, M. M. (Lebedev Inst. of Physics, Moscow). pp 2362-70 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.6).

In a nuclear photoemulsion NIKFI-BR-2 exposed at the Serpukhov accelerator by π^--mesons at 60 GeV/c the coherent interactions having one charged and two neutral mesons in a final state were studied. The spectra of γ-rays for the events with $\overline{\Sigma E\gamma} = 50$ GeV are compared with those obtained from the cosmic rays interactions having larger values of $\Sigma E\gamma$. (auth)

10487 IDENTIFICATION OF RELATIVISTIC PARTICLES EMITTED FROM 16.2-GeV/c PION NUCLEON COLLISIONS IN EMULSION. Kirk, H. G. Jr. Norman, OK; Univ. of Oklahoma (1972). 124p. University Microfilms Order No. 72-29,894.

Thesis.

Grain density measurements were made on the tracks of relativistic particles emitted from 16.2 GeV/c π^-–nucleon collisions in Ilford K-5 emulsion. The grain densities were determined directly from the gap-length distributions as well as from track lacunarity and the more traditional blob density. These results, when combined with multiple Coulomb scattering data previously obtained, allow for the identification of fast nonstopping particles. The restricted rate of energy loss by ionization in Ilford K-5 emulsion for fast singly charged particles is found to be well described by the Sternheimer equation with the energy cutoff $T_{max} = 100$ KeV. Because of experimental constraints imposed, the track selection was mostly confined to the fast forward particle tracks leaving the collision sites. Most of these particles are found to be pions, with kaons and electrons also present. The

quantity of kaons observed appears to be substantially higher than expected. (Diss. Abstr. Int., B)

10488 NUCLEAR LEVELS AS ANALYZERS OF HIGH ENERGY INTERACTIONS. Scipione, D.; Mehlhop, W.; Garland, R.; (and others) (Univ. of California, San Diego, La Jolla). Phys. Lett.; 42B: No. 4, 489-92(25 Dec 1972).

The excitation of the first level of carbon in association with scattering of pions from 0.4 to 3 GeV/c, and the angular correlation of the 4.4 MeV photon were observed. The possibility of selecting diffractive productions with the method is discussed. (auth)

10489 SPIN–PARITY AND HELICITY OF DIFFRACTIVELY PRODUCED N*. Oh, Y. T.; Fung, S. Y.; Kernan, A.; (and others) (Univ. of California, Riverside). Phys. Lett.; 42B: No. 4, 497-500(25 Dec 1972).

Analysis of the two-body πN decay for N*(1500) and N*(1690), produced by diffraction dissociation, shows that these states have spin $^3/_2$ and $^5/_2$ respectively, and odd relative parity. Both states are produced with helicity $\pm^1/_2$ in the t-channel. (auth)

10490 DIFFRACTION DISSOCIATION OF PIONS BY NUCLEI AT ENERGIES OF 17 AND 45 GeV. Azimov, S. A.; Beter, E. V.; Gulyamov, U. G.; (and others) (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 6, 22-6 (1971). (In Russian).

Two reactions for coherent production of pions were studied at 17 and 45 GeV: $\pi^-A \rightarrow A2\pi^-\pi^+$, and $\pi^-A \rightarrow A3\pi^-2\pi^+$. The cross sections of these two reactions were compared over a range of energies, using borrowed data. Deck diagrams were utilized in the interpretation of the data. (K.S.W.)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 10425.

General

Refer also to abstracts 10679, 10707, 10727, and 11063.

10491 (CERN–72-17) PROCEEDINGS OF THE 1972 CERN SCHOOL OF PHYSICS (ORGANIZED IN COLLABORATION WITH ICTP, TRIESTE), GRADO, ITALY, 15–31 MAY 1972. (European Organization for Nuclear Research, Geneva (Switzerland)). 12 Oct 1972. 597p. Dep. NTIS (U. S. Sales Only).

Seven lectures were included. Separate abstracts were prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 10450, 10492, 10511, 10512, and 10567–10569.

10492 (CERN–72-17, pp 491-540) INCLUSIVE PROCESSES AT HIGH ENERGIES. Ezhela, V. V.; Logunov, A. A.; Mestvirishvili, M. A.; Petrov, V. A. (Inst. for High Energy Physics, Serpukhov, USSR). 12 Oct 1972.

The average multiplicity of particles with bounded momenta in the cms at large and small angles for inclusive processes is discussed. An analysis of the hypothesis of pionization, scale invariance, and limited fragmentation in terms of analyticity and unitarity is presented. Particle production at large angles and the hypothesis of scale invariance and analyticity, unitarity, and the upper bound of the decrease of differential cross sections for inclusive processes are considered. (J.F.P.)

10493 (CONF-710974–4) THESES, HYPOTHESES, AND PROBLEMS OF ELEMENTARY PARTICLE PHYSICS. Joos, Hans (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). [1971]. 51p. (In German). Dep. NTIS (U. S. Sales Only).

From Autumn conference on high energy physics; Hamburg, Germany (13 Sep 1971).

The theoretical and experimental data which form the basis of the present knowledge of elementary particle physics are summarized to illustrate the still-unsolved problems and to serve as the basis for discussion. (J.S.R.)

10494 ZEROS IN DIFFERENTIAL CROSS SECTIONS AT HIGH ENERGIES. Arai, Masahiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1429-30(Oct 1972).

Various results on zeros in differential cross sections are generalized to $a + b \rightarrow \bar{c} + \bar{d}$ scattering. The zeros considered are characteristic of the amplitude not expressed by a simple Regge pole as in the case where the Pomeranchuk theorem cannot be applied. More generally, it is assumed that $\tilde{F}(s,o)$ behaves like $Cs \ln^{\alpha+1}s$ and $\sigma(s)$ like $C'\ln^{\beta}s$. For such an amplitude it is shown that there are zeros approaching $t = 0$ as $s \rightarrow \infty$ and that the number increases, if $2\alpha - \beta > -1$. (L.B.S.)

10495 NOTES ON ULTRA-HIGH-ENERGY INTERACTION PROCESSES. Peak, L. S. (Cornell-Sydney Univ. Astronomy Center, Sydney). Nuovo Cim.; 12A: No. 3, 533-40(1 Dec 1972).

An attempt is made to develop a picture of ultra-high energy interaction processes which is consistent with the known data of cosmic rays. At low energies these data are drawn from the results of emulsions, emulsion chambers and other installations (such as the Echo Lake facility). At high energies these data are inferred from the response of the giant arrays designed to measure air showers initiated by primaries with incident energy (E_0) as high as (10^{19} to 10^{20}) eV. A possible link between multiplicity increase and observed transverse momenta is discussed in terms of four-momentum damping. In addition, resonance formation, and expected average elasticity are considered. (auth)

10496 CORRELATIONS IN INCLUSIVE REACTIONS. Ellis, J. (Stanford Univ., CA); Finkelstein, J.; Peccei, R. D. Nuovo Cim.; 12A: No. 3, 763-87(1 Dec 1972).

The nature of correlations in inclusive hadronic reactions is considered. Assuming the existence of hadronic scaling, the constraints imposed by energy-momentum conservation are studied, and it is deduced that they seem not to lead to correlations of long range in rapidity. It is shown that short-range correlations must obey various restrictions in order to guarantee consistency with conservation laws. Following Le Bellac and Wilson, the nature of correlations when diffractive processes are present are investigated, and it is shown that these processes lead to long-range correlations. In Mueller's Regge analysis of inclusive reactions these would correspond to failures of the Pomeranchuk singularity to factorize. Lower bounds are established for the average correlation between two particles of similar type when there is nonshrinking diffraction. The existence of correlations between particles of different types cannot be established unless specific additional assumptions are made. The implications of the results for experiment are discussed. (auth)

10497 WAVE EQUATIONS FOR ZERO-MASS PARTICLES WITH INVARIANT HELICITIES. Seetharaman, M.; Simon, M. T.; Mathews, P. M. (Univ. of Madras). Nuovo Cim.; 12A: No. 3, 788-800(1 Dec 1972).

A brief discussion of the difficulties associated with taking the limit $m \rightarrow 0$ in massive-particle equations of the form $i(\partial\psi/\partial t) = H\psi$, in which ψ transforms according to the $D(0,s) \oplus D(s,0)$ representation of the homogeneous Lorentz group is presented. It is pointed out that, though the Hamiltonian H tends to a well defined form as $m \rightarrow 0$, the resulting wave equation is still unsatisfactory as the invariant scalar product (in the space of solutions of the wave equation) has an unacceptable form. It is observed that this difficulty is due to the indecomposability of the representation of the Poincaré group over wave functions transforming as $D(0,s) \oplus D(s,0)$ in the massless case. Making due allowance for this fact, in close parallel to the treatment for massive particles, wave equations for zero-mass particles with invariant helicities $\pm s$ are obtained. The relevant invariant scalar products are also determined. (auth)

10498 GENERAL OPTIMIZED DATA REPRESENTATION BY AN ANALYTIC FUNCTION. Presnajder, P. (Comenius Univ., Bratislava). Lett. Nuovo Cim.; 5: No. 6, 520-4(7 Oct 1972).

The problem of data representation by an analytic function or with the analytic extrapolation is considered. Restriction is made to the case in which the function is analytic in a region which can be mapped onto the unit disc. (J.F.P.)

10499 NULL PLANE RESTRICTIONS OF CURRENT COMMUTATORS. Brandt, R. A.; Otterson, P. (New York Univ., NY). J. Math. Phys. (N. Y.); 13: No. 11, 1714-22(Nov 1972).

Some mathematical aspects of the problems of defining restrictions of quantum fields and commutators of such fields to null planes are considered. Precise meanings are given to these restrictions, and it is discussed how these lead to unambiguous derivations of the usual formal results. Various definitions of null plane charges are discussed and related, and some of their properties derived such as vacuum annihilation. Finite null plane restrictions for causal solutions of the Klein–Gordon equation are defined and exhibited. Commutator functions defined by integral representations with various spectral functions are then considered. Light cone operator product expansions are used to calculate some null plane current commutators. In this way one can give precise derivations of Fubini sum rules and electroproduction structure function asymptotic behavior. (auth)

10500 HIGH ENERGY PHYSICS INDEX. VOLUME 10, No. 20, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 85p.

10501 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 19, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 92p.

10502 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 23, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 75p.

10503 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 24, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 65p.

10504 HIGH ENERGY PHYSICS INDEX. VOLUME 10, NO. 21, 1972. Leopoldshafen, Ger.; Zentralstelle fuer Atomkern-energie-Dokumentation (1972). 65p.

10505 INEQUALITY RELATING CROSS SECTIONS TO POLARIZATION FROM ISOSPIN CONSERVATION. Joseph, A. (Tel-Aviv Univ., Ramat Aviv, Israel). Phys. Lett.; 42B: No. 3, 368(11 Dec 1972).

The validity of an inequality relating cross sections to polarization imposed by isospin conservation is extended to the case when only the even multipole part of the polarization can be measured. (auth)

10506 EXCHANGE DEGENERACY AND DIP MECHANISMS IN HIGH ENERGY COLLISIONS. Tran Thanh Van, J. (Paris Univ., Orsay, France). pp 5.1-5.36 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

Qualitative features of Regge cuts, exchange degeneracy, structure minima in the differential cross sections, and the two classes of high energy model and some decisive tests of these two classes of model are reviewed. (France)

10507 PARTON MODEL AND FIELD THEORY IN THE FRAMEWORK OF INFINITE MOMENTUM. Bouchiat, Claude; Fayet, Pierre; Meyer, Philippe (Paris Univ., Orsay, France). pp 9.1-9.21 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, france (3 May 1971). See CONF-710558.

The parton model was studied using quantum field theory in the framework of an infinite momentum system. (France)

10508 PHENOMENOLOGICAL STUDY OF HIGH ENERGY FORWARD NONDIFFRACTIVE REACTIONS USING THE STRONG ABSORPTIVE REGGE CUT MODEL. Richards, D. R. Ann Arbor, MI; Univ. of Michigan (1971). 141p. University Microfilms Order No. 72-29,179.

Thesis.

A previously developed model of elementary particle scattering is compared to relevant experimental data. The composite nature of strongly interacting particles is taken into account in describing small-angle scattering at high energy. Much of the observed angular dependence of scattering data is explained in terms of the extended spatial structure of the particles. In addition, the model incorporates the Regge formalism with its ability to describe the observed energy dependence. In this study, the free parameters of the model were determined by fitting available data for several reactions among mesons, baryons, and photons. Good agreement with the data is obtained in most cases. In those cases where the model fails to describe data correctly, possible changes are suggested in the existing picture of these reactions. Attention is given to the integration of this model of high energy scattering with the theoretical concept of duality, which relates high energy to low energy scattering. (Diss. Abstr. Int., B)

10509 INCLUSIVE PROCESSES AT HIGH TRANSVERSE MOMENTUM. Blankenbecler, R.; Brodsky, S. J.; Gunion, J. F. (Stanford Univ., CA). Phys. Lett.; 42B: No. 4, 461-5(25 Dec 1972).

The interchange theory for inclusive scattering at large transverse momentum is extended into kinematic regions where Regge effects are important. Hadronic bremsstrahlung is shown to lead inevitably to Reggeization of the fundamental production process as s goes to infinity for fixed, large, P_T. The cross sections are shown to rise to their ultimate scaling limit. This transition zone connects smoothly with the Feynman scaling region at low p_T, and the deep scale-invariant region at large $p_T \sim O(\sqrt{s})$. The inclusive results of the interchange theory have the form of the standard fragmentation, triple Regge, and pionization formulas in their respective regions, but in addition predict the behavior of the associated residues and trajectories at large t or p_T^2. (auth)

10510 COMMENTS ON PROPOSED TWO-COMPONENT SPIN-1/2 WAVE EQUATIONS. Flato, M.; Lindblad, G.; Nagel, B. (Kungliga Tekniska Hoegskolan, Stockholm). Phys. Scr.; 5: No. 4-5, 153-4(1972).

A recent proposal of two-component spin-½ wave equations is discussed and criticized. (auth)

Electromagnetic

Refer also to abstracts 10673, 10691, 10708, 10715, and 10726.

10511 (CERN-72-17, pp 125-225) INELASTIC LEPTON SCATTERING. Gourdin, M. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France). 12 Oct 1972.

Lectures are presented on inclusive inelastic lepton scattering by hadrons where only the final lepton is detected. Polarization effects are considered when the hadronic target has a spin ½. The electromagnetic and weak interactions are separated. The kinematics, positivity and current algebra sum rule, scaling in the deep inelastic region and experimental data, the quark parton model, and scaling functions for a nucleon target are covered. (J.F.P.)

10512 (CERN-72-17, pp 403-90) ELECTRON-POSITRON INTERACTIONS. Kramer, G. (Hamburg Univ., W. Ger.). 12 Oct 1972.

A summary is given of some theoretical aspects of $e^+ + e^-$ annihilation into hadrons at $1.0 < 2E < 3.0$ GeV in colliding beams; the total annihilation cross sections, one-particle distribution, and the general form of the cross section. (J.F.P.)

10513 (CONF-710974-1) THEORY OF DEEP INELASTIC LEPTON SCATTERING. Dahmen, H. D. (Heidelberg Univ. (West Germany). Institut fuer Theoretische Physik. Kernforschungszentrum, Karlsruhe (West Germany)). 1971. 140p. (In German). Dep. NTIS (U. S. Sales Only).

From Autumn conference on high energy physics; Hamburg, Germany (13 Sep 1971).

The electron–nucleon scattering was discussed. After a detailed treatment of the kinematics of this problem the predictions of the different variants of the parton model were adduced. The kinematics and expressions of the parton model for the deep inelastic neutrino–nucleon scattering process were represented. The relation of the results of the deep inelastic scattering experiments with the behavior of current commutators on the light cone was shown. This relation was investigated generally. The Wilson development for the behavior of the commutators at short distances and the quark light-cone algebra as a specific model were discussed. Relations and sum rules, which correspond to those of the parton model, were then derived. (tr-auth)

10514 (DESY-72/50) APPLICATION OF DUALITY PRINCIPLES TO DEEP INELASTIC REACTIONS. Chainchian, M.; Kitakado, S.; Pallua, S.; Renner, B.; De Azcarraga, J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 25p. Dep. NTIS (U. S. Sales Only).

General constraints of duality are applied to deep inelastic structure functions in a systematic manner. In analogy with hadronic duality two components are admitted: one being constrained to nonexotic SU_3 representations in two channels simultaneously, the other being a generalization of the Pomeron effect. The results can be best interpreted in terms of a quark-parton model with the usual valence quarks and a sea of SU_3 singlet quark-antiquark pairs, and the results of that model are reproduced without having to deal with quarks explicitly. On the theoretical side a statement of exchange degeneracy on the light cone is given, and a speculative connection between the Pomeron effect and the matrix elements of the quark kinetic energy tensor is obtained. (auth)

10515 (DESY-72/57) HIGH-ENERGY ELECTROPRODUCTION AND PHOTOPRODUCTION OF KAONS. Levy, N.; Majerotto, W.; Read, B. J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 51p. Dep. NTIS (U. S. Sales Only).

A simple Regge model for high energy K^+ photoproduction is constructed from kaon and exchange degenerate $K^*(892)-K^{**}(1420)$ trajectories, together with absorption of the low partial waves. Use of SU(3) symmetry and vector meson dominance results leaves little freedom in choice of parameters. The model requires the Λ recoil polarization asymmetry to be negative in accordance with recent measurement. The main purpose however is an attempt, by extrapolation of the photoproduction model to lower energies and spacelike photon four-momenta, to predict cross sections for K^+ electroproduction. (auth)

10516 (NP-19613) DOES BJORKEN SCALING IMPLY THE PARTON MODEL? Note No. 391. Parisi, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 13 Jul 1972. 10p. Dep. NTIS (U.S. Sales Only).

In the framework of renormalized quantum field theory it is proven under a technical assumption that the presence of Bjorken scaling in deep inelastic electron proton scattering implies the validity of the parton model. (auth)

10517 LIGHT CONE CURRENT ALGEBRA AND REGGE COUPLINGS. Testa, M. (CERN, Geneva). Phys. Lett.; 42B: No. 2, 267-70(27 Nov 1972).

Considerations on Regge couplings in hadron–hadron scattering and deep inelastic electroproduction are shown to be suggested by canonical light cone expansion. The particular case in which no canonical scalar fields are present is examined in detail. (auth)

10518 FORM FACTORS AND EQUAL-TIME COMMUTATORS. Yang, T. C. (Univ. of California, San Diego, La Jolla). Nuovo Cim.; 12A: No. 2, 387-408(21 Nov 1972).

The equal-time commutator of the charge and current sandwiched between states of unequal momenta is studied, considering the momentum transfer between the two states as a new independent variable. One notes that usual current algebra sum rules are obtained at zero momentum transfer, probing the equal-time commutator by using q^2 (the 4-momentum square of the current) as a variable, namely, the Adler–Weisberger and the Cabibbo–Radicati sum rules. By the new approach, the dispersion method (Dashen–Fubini–Gell-Mann sum rule) and the current algebra method (using Ward identity, specifically the Weisberger approach) are studied. It is found that they give the same result for the pion, but different results for the nucleon. The difference (due to spin) is traced down to the question of subtraction. (auth)

10519 GENERALIZED VECTOR DOMINANCE AND INELASTIC ELECTRON NUCLEON SCATTERING: THE SMALL ω' REGION. Sakurai, J. J. (Univ. of California, Los Angeles); Schildknecht, D. Phys. Lett.; 42B: No. 2, 216-20(27 Nov 1972).

The generalized vector dominance model for inelastic electron nucleon scattering is extended to the small ω' region by taking into account the increase of $-t_{min}$ with q^2 in exclusive electroproduction. (auth)

10520 IMPLICATIONS OF A LARGE PIONIC CHARGE RADIUS. Levin, D. N.; Okubo, S. (Univ. of Rochester, NY). Phys. Lett.; 42B: No. 2, 233-6(27 Nov 1972).

The pion's charge radius is rigorously bounded by the modulus of the time-like charge form factor and the p-wave $\pi\pi$ scattering phase shift. The large radius, suggested by experiment, must be correlated with a large phase shift just above threshold. (auth)

10521 ISO-SCALAR PART OF NUCLEON ELECTROMAGNETIC FORM FACTORS. Furuichi, Susumu (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1418-20 (Oct 1972).

The effect of the uncorrelated three-pion state in the isoscalar part of the nucleon form factors is examined. The 3π contribution in the vicinity of the ω-meson peak is considered. (L.B.S.)

10522 MULTIPLE SCATTERING OF CHARGED PARTICLES IN A MEDIUM IN AN AXISYMMETRIC MAGNETIC FIELD WITH ENERGY LOSS. Kimel, L. R.; Salimov, O. N. (Moscow Engineering Physics Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 918-22(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1154-60(Jun 1972).

The distribution function is obtained for charged particles in a medium in an axisymmetric magnetic field, taking account of energy loss. In the small-angle approximation, the magnetic field does not affect the shape, but only the width of the distribution, for multiple Coulomb scattering. Results of numerical calculations for muons with an initial momentum of 30 GeV/c moving in iron are presented for focusing and defocusing fields. (auth)

10523 VECTOR-MESON DOMINANCE AND SMOOTHNESS OF INVARIANT AMPLITUDES IN $\pi\Delta(1236)$ ELECTROPRODUCTION. Bartl, A. (Univ., Mainz); Majerotto, W.; Schildknecht, D. Nuovo Cim.; 12A: No. 3, 703-23(1 Dec 1972).

The longitudinal and transverse parts of the $\pi\Delta(1236)$ electroproduction cross section are predicted from real photoproduction within the framework of vector-meson dominance, using the assumption of approximate mass independence of the invariant amplitudes for $VN \to \pi\Delta(1236)$. (auth)

10524 RESONANT SPIN ROTATION: A NEW LEPTON g - 2 TECHNIQUE. Ford, G. W. (Univ. of Michigan, Ann Arbor); Luxon, J. L.; Rich, A.; Wesley, J. C.; Telegdi, V. L. Phys. Rev. Lett.; 29: No. 25, 1691-5(18 Dec 1972).

An extension of the Michigan g-factor work that permits measurement of the g–2 precession frequency of free leptons by a resonance technique is described. Preliminary results with electrons (accurate to about 100 ppm in the anomaly) indicate that the technique may be of use in various future experiments. (auth)

10525 ELECTROMAGNETIC INTERACTIONS OF PARTICLES WITH SPIN. II. ELECTRON BREMSSTRAHLUNG AND PAIR PRODUCTION. Waldenstroem, S.; Olsen, H. A. (Univ. of Trondheim, Norway). Nuovo Cim.; 12A: No. 3, 683-702(1 Dec 1972).

Bethe–Heitler cross sections for electron bremsstrahlung and pair production in the field of a target particle of arbitrary spin are obtained, including recoil effects. Formulas for extreme relativistic energies are obtained as special cases. A formula for symmetric pair production, valid for all energies and emission angles, is given. Inelastic target processes are included in a straightforward manner. (auth)

10526 POLARIZATION OF NUCLEONS ARISING DURING ELECTRODISINTEGRATION OF LIGHT NUCLEI. Tartakovskii, V. K. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 432-8(Mar 1972). (In Russian).

Polarization of high energy nucleons arising during inelastic scattering of fast electrons by light nuclei is calculated. A noticeable value of polarization is due to both the spin-orbit interaction of a knocked out nucleon with a nucleus and electromagnetic interaction of a nucleon with an electron. Nucleon polarization is strongly depended of the imaginary part of the distorting potential. (auth)

10527 RADIOACTIVE DECAY OF THE ω MESON: $\omega \to 2\pi^0 + \gamma$. Gakh, G. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 417-23(Mar 1972). (In Russian).

Radiative decay of the ω-meson ($\omega \to 2\pi^0 + \gamma$) is considered in the pole model which takes into account the contribution of the σ- and ρ-mesons in the intermediate state. Analytical expressions for the energy spectrum of the photons are obtained. Coupling constant $g_{\omega\sigma\gamma}$ is calculated, using experimental value for the ratio $\Gamma(\omega \to 2\pi^0 + \gamma)/\Gamma(\omega \to \pi^0\gamma)$. (auth)

10528 $\omega-\rho$ MIXING EFFECT IN THE REACTIONS $e^+e^- \to \pi(\eta) + \gamma$. Gakh, G. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 413-16(Mar 1972). (In Russian).

The contribution of the electromagnetic mixing of ω- and ρ-mesons to the reactions $e^+e^- \to \pi^0(\eta) + \gamma$ was calculated. (auth)

10529 ELECTROPRODUCTION OF PIONS ON NUCLEONS IN THE CHIRAL LAGRANGIAN PHENOMENOLOGICAL MODEL. Gendenshtein, L. E.; Tkach, V. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 361-7(Mar 1972). (In Russian).

Pion electroproduction on a nucleon is considered near the threshold in the model of a phenomenological chiral Lagrangian invariant with respect to a chiral $SU(2) \times SU(2)$ group. The expression is obtained for the process amplitude. Consequences are discussed of introducing triplets of vector and axial vector mesons into the circuit. (auth)

10530 PHOTOPRODUCTION OF STRANGE PARTICLES ON NUCLEONS NEAR THE THRESHOLD. Krive, I. V. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 1039-42 (Jun 1972). (In Russian).

Data on the relative cross sections of the reactions $\gamma + N \to \Lambda(\Sigma) + K$ were analyzed on the basis of the amplitudes of the photoproduction of strange particles which had been obtained within the framework of relativistic gradient-invariation Born approximation. The values of the magnetic moments $\mu\Sigma^0$, $\mu\Sigma$, and $\mu\Lambda\Sigma$ the predicted SU(3)-symmetry, do not contradict the experimental data. The constant of the $\gamma p \to \Sigma^+K^0$ interaction was found, $g^2(p,\Sigma^+K^0)/4\pi = 1.4 \pm 0.6$. (tr-auth)

10531 DYNAMICS OF THE DIRAC ELECTRON IN THE ELECTROMAGNETIC AND UNIFORM MAGNETIC FIELDS. Oleinik, V. P. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 990-1000(Jun 1972). (In Russian).

It is shown that a strict decision of the scattering problem of a particle by the external potential is possible only in the multiparticle theory if a particle has the continuum of the negative energy states. A general formula is obtained for the probability amplitude of the particle scattering by the external potential. This formula is used when considering the quantum transitions of Dirac's electron in the uniform magnetic field under the action of the electromagnetic wave of the arbitrary intensity. (auth)

10532 REAL PARTS OF AMPLITUDES OF PHOTOPRODUCTION PROCESSES OF NEUTRAL VECTOR MESONS ON NUCLEONS AND PROCESSES OF GAMMA SCATTERING ON NUCLEONS PREDICTED BY QUARK MODEL. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 909-13(Jun 1972). (In Russian).

The relative values of the real parts of the amplitudes of the

process $\gamma + N \rightarrow N + V$, $\gamma + N \rightarrow \gamma + N$ are obtained, using the relations between amplitudes of these processes and the elastic meson–nucleon scattering amplitudes, which are valid in a quark model. The real parts of the ω- and ρ-photoproduction processes exceed the values usually used in literature. The relative values of the amplitudes of the incoherent mechanisms in the V-meson photoproduction are also obtained. (auth)

10533 FORM FACTORS OF ELECTROPRODUCTION OF BARYON RESONANCES ON NUCLEONS. Gakh, G. I.; Kulish, Yu. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 903-8(Jun 1972). (In Russian).

The k^2-dependence of the form factors of electroproduction of the resonances $P_{11}(1470)$, $D_{13}(1520)$, $F_{15}(1688)$, $S_{11}(1700)$ on neutrons was calculated in the framework of the Walecka–Zucker model. The sensibility of the model to a change in the resonance mass is considered. The dependence of the ratio of the multipole amplitudes at $k^2 = 0$ on the energy W was calculated for N*(1236), N*(1520), N*(1688) on the proton. (auth)

10534 DUALITY ASPECT OF ep INELASTIC SCATTERING IN LOW-q^2 REGION. Kuroda, M. (Tokyo Univ.). Lett. Nuovo Cim.; 5: No. 14, 921-4(2 Dec 1972).

It is shown that semi-local duality applied to the structure function of ep inelastic scattering properly predicts the cross section t-dependence of electro-resonance production processes. The production cross section of the fourth resonance N(1920) is predicted. (J.F.P.)

10535 FIXED POLES IN CURRENT AMPLITUDES. Ezawa, Z. F. (Tokyo Univ.). Lett. Nuovo Cim.; 5: No. 14, 935-40 (2 Dec 1972).

The formalism for fixed poles in the virtual Compton amplitude, previously examined within a specific field-theoretic framework, is generalized so as to treat octet currents. A fixed pole at $J = 0$ in the symmetric part and one at $J = 1$ in the antisymmetric part of these current amplitudes are obtained with respect to the unitary indices. (J.F.P.)

10536 PHENOMENOLOGICAL MASS OPERATOR FOR HADRONS. II. Ito, D.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 5: No. 15, 1001-4(9 Dec 1972).

A previously proposed simple mass operator for the internal dynamics of hadrons is used to calculate the baryon electromagnetic form factors. (J.F.P.)

10537 SUBMUONS AND HAS. Dedenko, L. G.; Zheleznykh, I. M. (Lebedev Inst. of Physics, Moscow). pp 2201-10 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The possibility is considered that horizontal air showers (HAS) with $E > 1000$ GeV could be produced by hypothetical light charged particles (scalar or spinor) with a mass of several MeV and a lifetime less than 10^{-10} sec. Pairs of such particles, if they exist, could be produced by high energy photons in the upper atmosphere and could then travel a long distance because of the relativistic time dilatation and give HAS by decays and bremsstrahlung. (auth)

10538 NUCLEAR CASCADES IN A DENSE MATTER. Fetisov, I. N.; Morozov, A. E.; Slavatinskii, S. A. (Lebedev Inst. of Physics., Moscow). pp 2371-80 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

A simulation of the nuclear-electromagnetic cascade development in an ionization calorimeter was carried out at the energy $E_0 = 10^2$ to 10^3 GeV using a Monte Carlo method. The experimental data fit the chosen model. The various characteristics of an ionization calorimeter were calculated. (auth)

10539 ANALYSIS OF MUON GROUPS UNDER GROUND. Kelner, S. P.; Kotov, Yu. D.; Logunov, V. M. (Moscow Engineering-Physics Inst.). pp 2414-20 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6)

A theoretical study of the processes giving rise to the production of muon groups under ground is presented. Two methods of generation, i.e., direct production of muon pairs by muons due to electromagnetic interaction and the processes in extensive atmospheric showers were taken into consideration. For the groups resulting from the first mechanism an average energy of the muons involved in the groups was calculated; their energy spectrum was determined; an average distance between the muons, with regard for the multiple scattering, was calculated; an angular distribution for the muon groups at a given depth was obtained and an expected probability of the observation of the groups has been calculated as well. A number of events was calculated for the EAS muons when two, three, four, or five muons go through the instrument. The average muon energy of such groups was determined. The probability of the events versus the instrument's area was found. Intensities of the muon groups due to the above two mechanisms can be compared. The obtained results were compared with the experimental data. (auth)

10540 INFLUENCE OF THE NUCLEAR FORM FACTOR ON THE CROSS SECTION OF ELECTRON PAIR PRODUCTION BY HIGH ENERGY MUONS. Kokoulin, R. P.; Petrukhin, A. A. (Inst. of Engineering-Physics, Moscow). pp 2436-45 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The influence of the nuclear form factor on the cross section is considered. The analytical correction to the differential cross section is obtained. The mean momentum transferred to the nucleus is calculated at various energies of the particles involved. The influence of the finite nuclear size on the number of cascade showers generated by cosmic muons due to pair production is evaluated. (auth)

10541 CURRENTS, COLLIDING BEAMS, AND THE LIGHT CONE. Friedman, M. H.; Nath, P.; Arnowitt, R. (Northeastern Univ., Boston). Phys. Lett.; 42B: No. 3, 361-4(11 Dec 1972).

Currents of scale dimension 3 of the field-current identity type arise naturally from the principles of broken scale invariance. Applications at intermediate energy to $e^+ + e^-$ annihilation into four charged pions, and at high energy to light cone commutators are given. (auth)

10542 NEW DUALITY RESULTS FOR THE PROTON–NEUTRON ELECTROPRODUCTION STRUCTURE FUNCTION DIFFERENCE. Von Gehlen, G. (Univ., Bonn); Wessel, H.; Rubinstein, H. R. Phys. Lett.; 42B: No. 3, 365-7(11 Dec 1972).

It is shown that the s-channel resonance contributions build up the $I_t = 1$ Compton amplitude in the deep inelastic region. This is done by using ω_W-scaling to relate the low energy photo- and electroproduction data and theory to the SLAC-MIT proton-neutron structure function difference measurements. (auth)

10543 GAUGE INVARIANCE AND SCALING IN RESONANCE MODELS OF THE VERTEX. Leutwyler, H. (Univ., Bern). Helv. Phys. Acta; 45: No. 2, 182-96(1972).

The vertex function associated with the interaction of a virtual photon of mass q^2, a scalar field of mass k^2 and a scalar particle sitting on its mass shell are analyzed. The singularities in k^2 and q^2 are taken to be simple poles characterized by linear trajectories. The behavior of the vertex for high virtual masses is assumed to be governed by a scaling law which corresponds to a canonical singularity on the light cone. The general gauge invariant vertex function consistent with these requirements is constructed. (auth)

10544 DIFFERENTIAL CROSS SECTIONS FOR PROCESSES OF NEUTRAL VECTOR MESON PHOTOPRODUCTION ON NUCLEONS IN THE QUARK MODEL. Rekalo, M. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 238-45(Feb 1972). (In Russian).

Relations between the differential cross sections of the processes $\gamma + N \rightarrow N + V^0$ ($V^0 = \rho, \omega, \varphi$) and the differential cross sections of different processes of meson-baryon scattering are found which are valid in the very general variant of the quark model for the arbitrary quark amplitudes. The contribution of the real parts of the quark amplitudes and the contribution of those quark amplitudes which describe change-exchange K^0-meson scattering are taken into account in derivation of these relations. The relations between the differential cross sections valid for some probable hypotheses on the quark amplitude are also investigated in detail. These relations may be of great use for checking different consequences of the quark model and the vector dominance hypothesis in conformity with the vector meson photoproduction processes on nucleons. (auth)

10545 PHOTOPRODUCTION OF LEPTON PAIRS AND CALCULATION OF FORM FACTORS FOR ELECTROMAGNETIC MULTIPOLE NUCLEAR MOMENTS. Kerimov, B. K.; Gavkhari, A. El. Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 3, 636-40(Mar 1972). (In Russian).

The differential cross section of formation of longitudinally

polarized electron-positron pairs (or muons) by circularly polarized γ quanta was investigated in the field of a nucleus with multipole moments after averaging according to the initial spin states of the nucleus and a summation according to the terminal spin states of the electron and the nucleus. The calculations made allowance for charge distribution, electric quadrupole, magnetic dipole and octupole moments for the nucleus. (K.S.W.)

10546 WEAKLY BOUND STATES OF A CHARGED PARTICLE IN THE FIELD OF A FINITE DIPOLE. Abramov, D. I.; Komarov, I. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 13: No. 2, 209-21(Nov 1972). (In Russian).

Energy levels of a charged particle moving in the field of a finite dipole embedded into continuum by infinite groups when a dipole moment becomes less than some critical value are studied. Formulas for these critical values and the eigen-energies in their neighborhoods are obtained. It is shown that the eigen-energies decrease exponentially when the dipole moment tends to a critical value. (auth)

10547 SIDEWISE DISPERSION CALCULATION OF THE NUCLEON ANOMALOUS MAGNETIC MOMENTS USING A VENEZIANO MODEL. Kubick, F. L. Brooklyn; Polytechnic Inst. of Brooklyn (1972). 99p. University Microfilms Order No. 72-28,255.

Thesis.

The nucleon anomalous magnetic moments are calculated using sidewise dispersion relations. The absorptive part of the nucleon photon vertex appearing in the dispersion integral is approximated by pion nucleon intermediate states. This procedure relates the nucleon anomalous magnetic moments to the pion photoproduction amplitude and the sidewise mesonic form factors. The photoproduction amplitude is expressed in terms of a modified form of a recently proposed Veneziano model. It is shown that the Veneziano model justifies the use of low energy approximations. Guided by this, the sidewise mesonic form factors are given by three different models appropriate to the low energy region. The first of these is the point vertex model which yields constant form factors. The second model results from a scattering length approximated sidewise dispersion calculation. The third model is also constructed from sidewise dispersion relations, but it is assumed that the Roper (1470 MeV) resonance dominates the mesonic form factors. The results indicate that the Roper dominance model is totally insufficient to account for the isovector nucleon anomalous magnetic moment. In contrast the point vertex and scattering length models give somewhat excessive values for the isovector moment. The reason is traced to strong contributions from the N*(1236 MeV) resonance in the isovector channel of the photoproduction process. These N* contributions appear both directly and indirectly through the particular features of the Veneziano model in a manner indicative of the fact that the Veneziano model satisfies duality. All three models give acceptably low values for the isoscalar nucleon anomalous magnetic moment, a result favored by the absence of the N* resonance in the isoscalar channel. Finally an attempt is made to estimate the Roper-nucleon coupling constant by using a combined model for the mesonic form factors as suggested by the results. (Diss. Abstr. Int., B)

10548 ELECTROMAGNETIC CONVERSION PROCESSES IN STRONG MAGNETIC FIELDS. I. PHOTON ABSORPTION BY ELECTRONS IN STRONG UNIFORM MAGNETIC FIELDS. Urban, P.; Wittmann, K. (Univ., Graz). Acta Phys. Austr.; 35: No. 1-2, 9-31(1972). (In German).

The effective cross section for the photon absorption of an extremely relativistic electron in a strong homogeneous magnetic field was calculated. The appropriate wave functions of the electron are first derived. The effective cross section is then defined and the transition matrix elements were exactly calculated. By means of an asymptotic representation of this transition matrix element, which considers the extremely relativistic electron energies, the absorption cross section was calculated in this asymptotic approximation and numerically evaluated. The results were presented in graphic form and discussed. (tr-auth)

10549 PION ELECTROPRODUCTION AND SCALING. Dombey, N.; Shann, R. T. (Univ. of Sussex, Eng.). Phys. Lett.; 42B: No. 4, 486-8(25 Dec 1972).

The properties of the differential cross section for pion electroproduction in the scaling limit are predicted using PCAC and the light cone approach. Pion production of muon pairs is also considered. (auth)

10550 RELATION BETWEEN FORM FACTORS AND THE SCALING FUNCTIONS IN ELECTROPRODUCTION AND NEUTRINO REACTIONS. Langacker, P.; Suzuki, M. (Univ. of California, Berkeley). Phys. Lett.; 42B: No. 4, 453-6(25 Dec 1972).

It is shown that the relation between the asymptotic behavior of the transition and isovector elastic form factors and the threshold behavior of the scaling functions suggested by Drell and Yan, West, and Bloom and Gilman follows from precocious scaling and the equal-time algebra of currents. The relation for the isoscalar form factor depends on the nature of the J = 0 fixed pole. (auth)

10551 PION EXCHANGE MECHANISM IN THE INCLUSIVE REACTION $\gamma p \to \pi^- +$ ANYTHING. Hidaka, K.; Hosoya, A. (Tokyo Univ.). Lett. Nuovo Cim.; 5: No. 13, 856-8(25 Nov 1972).

The π^- production cross section in the inclusive reaction $\gamma p \to \pi^- +$ anything is calculated in the photon fragmentation region on the basis of the multi-Regge model with the Chew–Low extrapolation. It is found that the overall normalization of the inclusive cross sections and the shape of the calculated distribution function is in good agreement with experiments. (L.B.S.)

10552 NUCLEAR PHYSICS OF NUCLEONS (RESONANCE MODEL OF INELASTIC ELECTRON AND NEUTRINO SCATTERING). Domokos, G. (National Accelerator Lab., Batavia, IL); Kovesi-Domokos, S.; Schonberg, E. Contract AT(30-1)-4076. Fields Quanta; 3: No. 2, 165-92(Oct 1972).

The physical aspects of a resonance dominance model of inelastic electron and neutrino scattering are discussed and its main predictions are summarized. Analogies with the electroexcitation of nuclei are stressed and possible relations with the quark-parton models are discussed. The possibility of a breakdown of scaling as a consequence of changes in the form of the baryon spectrum is investigated and a way of testing it experimentally is suggested. (auth)

Weak

Refer also to abstract 10139.

10553 (CONF-710974–5) DEEP INELASTIC LEPTON AND NEUTRINO SCATTERING. Rothe, K. D. (Heidelberg Univ. (West Germany), Institut fuer Theoretische Physik). [nd]. 33p. (In German). Dep. NTIS (U. S. Sales Only).

From Autumn conference on high energy physics; Hamburg, Germany (13 Sep 1971).

Practice problems and their solutions are given for the kinematics, differential effective cross section, the parton model, the relation between the light cone singularities and deep inelastic behavior, scale transformations, and light cone commutators and the quark algebra. (J.S.R.)

10554 (JINR-P1-6650) ONE MORE POSSIBLE EXPLANATION OF THE INCONSISTENCY OF THE MEASURED DECAY RATES $K_1^0 \to 2\gamma$ AND $K_1^0 \to 2\mu$. Lyubimov, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The existing contradiction between the measured decay rates $K_1^0 \to 2\gamma$ and $K_1^0 \to 2\mu$ is explained by the assumption that in experiments for measuring the decay rates $K^0 \to 2\gamma$, the two gammas originate mainly from the decay of some unknown neutral meson lighter than the K_1^0. The possibilities of creation of these mesons and their quantum numbers are discussed. (auth)

10555 $K_{S,L} \to \gamma\gamma$ DECAYS AND CP VIOLATION. Kohara, Y. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1425-6 (Oct 1972).

The effect of CP violation in $K_1^0 \to \gamma\gamma$ and $K_2^0 \to \gamma\gamma$ decays is studied. Bounds on the decay rate and polarization parameters are obtained. It is concluded that CP violation can be detected by measuring the plane polarizations of the photons from the K_L decay, but it is impossible to measure the circular polarizations of the photons from the K_S decay. (L.B.S.)

10556 COMPACT VERSION OF WEINBERG'S LEPTON MODEL. Saller, H. (Max-Planck-Institut fuer Physik and Astrophysik, Munich). Nuovo Cim.; 12A: No. 2, 349-64(21 Nov 1972).

A theory of interacting right-handed isospinors is extended by adding a left-handed isosinglet. This gives the possibility to construct the gauge fields of Weinberg's lepton model as bound states of these spinor fields. Gauge arguments are used to introduce the mass-zero photon and the weak interaction. (auth)

10557 CP-VIOLATING CHARGE ASYMMETRY IN THE DECAY $K_L^0 \to \pi\mu\nu$. McCarthy, R. L.; Brewer, J. H.; Budnitz, R. J.; (and others) (Univ. of California, Berkeley). Phys. Lett.; 42B: No. 2, 291-6(27 Nov 1972).

The $K_{\mu 3}^0$ charge asymmetry was measured to be $(6.0 \pm 1.4) \times 10^{-3}$. The error contains a major systematic contribution. Large corrections were made in order to exclude neutron-induced background events and to correct for the range difference between μ^+ and μ^-. (auth)

10558 NONLINEAR CHIRAL LAGRANGIANS AND THE $\Delta I = \frac{1}{2}$ RULE. Riela, G. (Univ., Palermo, Italy). Nuovo Cim.; 12A: No. 3, 737-55(1 Dec 1972).

A nonlinear chiral Lagrangian with symmetry breaking describing vector, pseudovector and pseudoscalar mesons is constructed. The weak currents deduced via field-current identities are used to compute to zeroth order in (m_π^2/m_ρ^2) the $K \to 2\pi$ decays. The $\Delta I = \frac{1}{2}$ rule is found to hold, and an estimate for the mass of the intermediate vector boson is given. (auth)

10559 CALCULATION OF THE $(K\pi)$ SCATTERING PHASE $\Delta^{1/2}(s)$, $f_k f_\pi|$ AND K_{l3} DECAY PARAMETERS BY PADE APPROXIMATIONS. Schuelke, L.; Wambach, U. M. (Ruhr-Univ., Bochum, Ger.). Lett. Nuovo Cim.; 5: No. 6, 517-19(7 Oct 1972).

It is found that the charge algebra commutation relations used with a quasi-one-particle state together with Pade approximations lead to improved results for the experimental K_{3l} decay parameters compared to the χ pole model and give a unique prediction for the ($l = 0$, $I = \frac{1}{2}$) $K\pi$ scattering phase shift in good agreement with the experimental down solution. (J.F.P.)

10560 NEUTRINO–LEPTON INTERACTIONS AND THE INTERMEDIATE VECTOR BOSON. Rekalo, A. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 914-21(Jun 1972). (In Russian).

The differential and total cross sections of the processes of elastic and inelastic $\bar{\nu}e$- and νe-scattering and that of production of the lepton pair as a result of the $\nu\bar{\nu}$-annihilation are calculated in a model of the weak interaction due to a charged vector boson. The W-boson mass dependence of the mean energy losses and of the mean neutrino scattering angle is analyzed in detail. Taking into account the W-boson resulted in the appearance of the minimal neutrino scattering angle dependence on the W-boson mass at high energy. The W-boson changed the energy dependence of the total cross sections of the considered processes at high energies and that of the mean energy loss in the process of νe-scattering in comparison with predictions of the local scheme of the weak V–A-interaction. (auth)

10561 ANALYSIS OF NEUTRINO EXPERIMENTS IN COSMIC RAYS. Volkova, L. V.; Zatsepin, G. T. (Lebedev Inst. of Physics, Moscow). pp 2459-68 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

Using different assumptions about the behavior of the neutrino-nucleon total cross section, the neutrino-induced muon spectra are calculated. The results of neutrino experiments in cosmic rays do not contradict the assumption of unlimited linear increase of neutrino-nucleon total cross section with neutrino energy, but because of large uncertainties in the values of some experimental parameters used in the calculations, the contrary possibility- the saturation of the linear increase of neutrino-nucleon cross section at a neutrino energy of some tens of GeV — can not be excluded. (auth)

10562 HIGHLY INELASTIC SCATTERING OF LEPTONS. Meyer, Philippe (Paris Univ., Orsay, France). pp 8.1-8.28 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

An elementary introduction to the highly inelastic scattering of leptons is presented: description of the kinematics, experimental results, and theoretical interpretations using the parton model, field theory models, the vector dominance model, Regge models, and diffraction models. (France)

10563 I. HARD PION CALCULATIONS: $K \to 2\pi$ DECAYS AND OTHER APPLICATIONS. II. VALIDITY OF THE HYPOTHESES OF PARTIAL CONSERVATION OF STRANGENESS-CARRYING CURRENTS. Chen, J. Rochester, NY; Univ. of Rochester (1972). 107p. University Microfilms Order No. 72-28,734.

Thesis.

The purpose is to study the content of current algebra and the hypothesis of partially conserved axial vector current in hard meson calculations. The general ideas, the problems and the basic techniques used are reviewed. An absolute calculation of the $K \to 2\pi$ decays through the usual Cabibbo form of weak interactions is analyzed. The motivation for this work is the recent criticism of T. D. Lee against the soft pion analysis in these decays. It is found that the matrix element for $K \to 2\pi$ decays is quite tractable in the soft kaon limit. Combining with the well known result that all $K \to 2\pi$ decay amplitudes vanish in the SU(3) limit, an extrapolation to the physical point is then performed using a recent suggestion of Okubo and Mathur. The calculation in the soft kaon limit is done by using the Bjorken theorem, field algebra and the Ward identities method used for hard pion calculations. The results thus obtained are consistent with the experiment. The continuously broken chiral symmetry model suggested by Okubo and Mathur is applied to analyze the corrections to some soft pion results. In particular corrections to the K_{l4} form factors, the generalized Goldberger-Treiman relations, and the Adler-Weisberger sum rules are discussed. The purpose is also to re-examine the hypotheses of partially conserved axial vector (PCAC) and vector currents (PCVC). Based on the usual dispersion theory version of PCAC and PCVC, the hadronic corrections to the Goldberger-Treiman relations for axial-vector and vector currents are evaluated. The high energy contribution is bound by the unitarity condition using Schwarz inequality, while the low energy contribution is evaluated by Born diagrams (with suitable SU(3) approximation for unknown coupling constants). A similar calculation for the PCAC hypothesis involving strangeness preserving axial vector currents was performed by Pagels. For the Goldberger-Treiman relations for strangeness carrying currents, corrections are found to be less than 10% for both the axial vector and vector cases, which shows that the PCAC and PCVC hypothesis provide a reasonably good approximation scheme. One was also able to set a bound for the strong coupling constant $G_{A\rho K}$. The κ-dominance in K_{l3} is also discussed. (Diss. Abstr. Int., B)

10564 WEAK-ELECTROMAGNETIC DECAYS OF NEUTRAL KAONS. Uy, Z. E. S. Stony Brook, NY; State Univ. of New York (1972). 81p. University Microfilms Order No. 72-30,468.

Thesis.

A presentation is given of work on the decay modes $K_S \to \gamma\gamma$, $K_L \to \gamma\gamma$, $K_S \to \mu^+\mu^-$ and $K_L \to \mu^+\mu^-$. With K_S taken as an exact CP eigenstate, (i.e., $K_S \equiv K_1$) and assuming the decay $K_1 \to \gamma\gamma$ is saturated by the 2π, the $K\pi\pi$ vertex is first order in the weak interaction and the $\pi\pi \to \gamma\gamma$ process goes by the exchanges of ρ, ω and ϕ mesons, the contributions to the decay rate of $K_1 \to \gamma\gamma$ from these exchanges are calculated. It is found that these contributions do not alter in any significant way the result of the perturbation calculation using the Born terms for the $\pi\pi \to \gamma\gamma$ reaction. Next, some implications of nonconservation of CP invariance for $K_L \to \mu^+\mu^-$ are discussed with reference to a recent experimental result on this decay. A simple pole model calculation of $\gamma\gamma \to 3\pi$ and its possible consequences in $K_L \to \gamma\gamma$ and $e^+e^- \to e^+e^-3\pi$ reactions are presented. Then, using the model-independent $2\gamma \to 3\pi$ amplitude recently derived from current algebra and gauge invariance, the total cross section for $2\gamma \to \pi^+\pi^-\pi^0$ and the total cross section for $e^+e^- \to e^+e^-\pi^+\pi^-\pi^0$ in the Weizsäcker-Williams approximation are calculated. Comments are also made in the cross sections for $\mu^+\mu^- \to \pi^+\pi^-\pi^0$ and its relevance to the decay $K_L \to \mu^+\mu^-$. As a possible explanation of the low decay rate for $K_L \to \mu^+\mu^-$, it was suggested that the decay rate for $K_S \to \mu^+\mu^-$ is anomalously large compared to the usual electromagnetic rate for this process. A detailed calculation of both the real and imaginary parts of the standard electromagnetic amplitude for the latter decay, taking into account the lowest mass intermediate states which are 2γ, $\pi^+\pi^-$ and $\pi^+\pi^-\gamma$, is therefore presented. (Diss. Abstr. Int., B)

10565 MACROSCOPIC CONSEQUENCES OF THE WEINBERG MODEL. Kirzhnits, D. A.; Linde, A. D. (Lebedev Inst. of Physics, Moscow). Phys. Lett.: 42B: No. 4, 471-4(25 Dec 1972).

Consequences of the Weinberg model are discussed in application to a large system of thermodynamically equilibrium weakly interacting particles. It is shown that at a temperature higher than about 10^3 GeV the symmetry broken at lower temperature is reestablished, the masses of the intermediate bosons vanish and weak interaction becomes a long-range one. The conditions are pointed out providing the appearance of anomalously great repulsion forces between the particles of the system. Some applications to the "hot" Universe model are considered. (auth)

10566 THEORETICAL STUDY OF ν–d SCATTERING. Singh, S. K. Pittsburgh; Carnegie-Mellon Univ. (1972). 122p. University Microfilms Order No. 72-23,218.

Thesis.

The differential cross section $d\sigma/dq^2$ where q^2 is the squared four momentum transfer is calculated for the process $\nu + d \to \mu^- + p + p$ using closure over the final two nucleon states and a Hulthen wave function for the deuteron. Using CVC values for the vector form factors, $d\sigma/dq^2$ is studied for various forms of the axial vector form factor. The effect of including D states and using various realistic deuteron wave functions is estimated The differential cross section $d\sigma/dq^2$ is also calculated by first calculating $d^2\sigma/dq^2dE\mu$ for the free final states and then nu-

merically integrating it over $E\mu$. The results are compared with those obtained in the closure approximation. The effect of final state interactions (FSI) on $d^2\sigma/dq^2dE\mu$ is discussed using the two nucleon continuum wave function derived from Reid potential with a hard core and a Hulthen wave function for the deuteron. The effect of FSI on $d\sigma/dq^2$ is shown to be small and the closure approximation works quite well. It is suggested that the closure approximation results should be used to analyze the experimental results. (Diss. Abstr. Int., B)

Strong (General)

Refer also to abstract 10686.

10567 (CERN-72-17, pp 1-53) REGGE PHENOMENOLOGY OF INCLUSIVE REACTIONS. Hong-Mo, Chan (Rutherford High Energy Lab., Chilton, Eng.). 12 Oct 1972.

In these lectures the generalized optical theorem is used to discuss strong interactions covering limiting fragmentation and scaling, fragmentation and the fragmentation vertex, phenomenology in the central region, and beyond single particle distributions. (J.F.P.)

10568 (CERN-72-17, pp 227-401) INCLUSIVE AND EXCLUSIVE DATA ANALYSIS IN LONGITUDINAL PHASE SPACE. Kittel, W. (CERN, Geneva, Switzerland). 12 Oct 1972.

The lectures on inclusive and exclusive data analysis in longitudinal phase space for strong interactions cover model-independent data presentation, n-particle inclusive and exclusive data, and whether n-particle reactions are conclusive. (J.F.P.)

10569 (CERN-72-17, pp 541-94) HIGH-ENERGY TWO-BODY PHENOMENOLOGY. Phillips, R. J. N. (Rutherford High Energy Lab., Chilton, Eng.). 12 Oct 1972.

The lectures on high energy two-body phenomenology of strong interactions cover Regge poles, duality, the Veneziano model, Regge cuts, and Regge cut models. (J.F.P.)

10570 (JINR-P2-6698) CALCULATION OF THE WEIGHT FUNCTIONS FOR THE INVARIANT FORM-FACTORS IN THE FREE FIELD APPROXIMATION. Vitsorek, E.; Matveev, V. A.; Robashik, D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The weight functions of the Jost–Lehmann–Dyson representation are calculated for the invariant form factors in the approximation of free fields of quantum electrodynamics. (auth)

10571 (LA-4980) EFFECTS OF STRONGLY ABSORPTIVE INTERACTIONS. Koch, J. H. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 29p. Dep. NTIS.

Thesis. Submitted to Massachusetts Univ., Amherst.

Recently the technique of optical potentials has been applied to the decaying eigenstates of exotic atoms. When Krell used this approach to interpret the x-ray spectrum of K-mesic atoms, the predicted eigenvalues showed an oscillatory dependence on the well parameters. Motivated by these intriguing effects the properties of absorptive systems are studied using a highly simplified model for the exotic atom. It is found that in the presence of strong absorption the spectrum of such a system consists of two distinct sets of eigenstates. In addition to the familiar "outer" eigenstates, which barely penetrate into the absorptive region, there is a class of "inner" states. These new eigenstates are essentially confined to the absorptive region. It is shown how nonlinearities, analogous to the ones observed by Krell, arise from the weak coupling between inner and outer states. To further generalize the observations, an analogous situation is described by a simple coupled channels model. Again one obtains a similar behavior of the eigenvalues, confirming thus that the inner states and the associated phenomena are physically meaningful and model-independent. Finally one turns to a realistic description of the K-mesic atom. One can fit the presently available data for shifts and linewidths of K-mesic atoms with one common set of potential parameters. Earlier first-order calculations are compared to the exact solutions obtained with these fitted parameters. For one case an inner state is traced down and it is shown how nonlinear effects arise as it crosses an outer state. The enormous width of the inner state makes observations of direct transitions unlikely. Therefore other ways to confirm the existence of inner states in exotic atoms experimentally are discussed. (auth)

10572 (SLAC-156) EIKONAL METHODS AND ABSORPTIVE EFFECTS IN HADRONIC PRODUCTION PROCESSES. Neff, T. L. (Stanford Linear Accelerator Center, Calif.). Sep 1972. Contract AT(04-3)-515. 106p. Dep. NTIS.

Thesis.

Absorptive effects are shown to be of utility in probing the nature of hadronic interactions and in testing models for multiple production. These effects result theoretically from the imposition of full s-channel unitarity upon model assumptions which do not possess it, and reflect the influence of small-scale (in configuration space) hadron dynamics. The globally smooth properties of hadronic production (scaling, Poisson multiplicities, etc.) are the result of the innumerable competitive mechanisms involved in a complex many-body problem. The local dynamics is reflected in small effects in certain experimental distributions. These effects and others are illustrated in a heuristic parton model which establishes the connection between multi- and poly-peripheral production mechanisms, the eikonal approximation and the nature of strong absorption. The strong cuts which are required by unitarity arise from the interplay between large distance (Regge) and small distance (non-Regge) dynamics. The usual nonrelativistic treatment of absorption is extended to the relativistic domain and the new features discussed. Divers mechanisms for hadronic production are then taken as Born terms to be unitarized by absorption and the experimental consequences explored. The large transverse momentum region is appreciably enhanced and relative momentum (and angular) correlations result. Comparison is made with experiment. (auth)

10573 PLATEAU'S PROBLEM AND THE VIRASORO CONDITIONS IN THE THEORY OF DUALITY. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1308-23 (Oct 1972).

It is pointed out that to recall Plateau's problem for the "world sheet" is relevant to understanding Virasoro's subsidiary conditions in dual-resonance models: If we choose isothermal parameters to describe the geodesical world sheet traced by the nucleonic string, then the four-positions should be harmonic and the condition for the choice of isothermal parameters proves to be related with the Virasoro condition. This point of view gives further insight into the correspondence to the situation we encounter when we need the Lorentz condition. (auth)

10574 COHERENT VECTOR GLUON FIELD IN HADRONS. Suura, H. (DESY, Hamburg). Phys. Lett.; 42B: No. 2, 237-40(27 Nov 1972).

A vector cohesive field in a hadron is treated in the classical limit. An asymptotic boson mass spectrum is derived, which becomes linear for infinitely heavy quarks. The size of the wave functions is scaled by the bare quark mass. (auth)

10575 LORENTZ COVARIANCE AND THE PHYSICAL STATES IN DUAL-RESONANCE MODELS. Goddard, P.; Rebbi, C.; Thorn, C. B. (CERN, Geneva). Nuovo Cim.; 12A: No. 2, 425-41(21 Nov 1972).

The properties of physical states in dual-resonance models under rotations in the little group of the resonance momentum are studied. It is shown how at a critical number of space–time dimensions this group can be represented just on the space of "transverse" states constructed by del Giudice, di Vecchia and Fubini (because these are then essentially the only states which couple). Further, the action of rotations in this group on the "photon" operators $A_n^\dagger$ is used to produce, for any number of dimensions, enough operators to create all the physical states both in the conventional model and in the model of Neveu and Schwarz. (auth)

10576 DISCRETE STRUCTURAL PROCESS IN THE LIMITING FRAGMENTATION OF VERY HIGH ENERGY HADRONIC REACTIONS. Iwai, J. (Waseda Univ., Tokyo). Lett. Nuovo Cim.; 5: No. 14, 895-901(2 Dec 1972).

The structure of a discrete structural process in the limiting fragmentation of very high energy hadronic interactions is evaluated. Various experimental data are systematically analyzed in two ways: the persistency parameter and the rapidity parameter to determine the existence of this discrete structural process. (J.F.P.)

10577 AUTOMODALITY IN STRONG INTERACTIONS. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Lett. Nuovo Cim.; 5: No. 14, 907-12(2 Dec 1972).

The asymptotic behavior of strong interactions at high energies is studied by means of generalized dimensional analysis and the automodality principle. The consequences of the automodality principle for strong interactions for the total cross sections, single- and two-particle distributions, and asymptotic behavior of the average multiplicity are discussed. (J.F.P.)

10578 INTERPRETATION OF MULTIPLE PROCESS. Gurwitz, S. A.; Daibog, E. I.; Rozental, I. L. (Moscow State Univ.). pp 2234-49 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The problems of principle bearing on multiperipheralism and collective interactions describing multiple processes are considered. The hydrodynamical theory is used to interpret the collective interactions. It was shown that at high energies the experimental evidence favors the hydrodynamical theory. Some heuristic possibilities of the theory are examined. (auth)

10579 ABOUT THE SUPERHEAVY FIREBALLS. Tretyakova, M. I. (Lebedev Inst. of Physics, Moscow); Zhdanov, G. B. pp 2250-8 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The nuclear interaction (in a photoemulsion) of the type 2 + 3 + 40p with an isotropic angular distribution of nearly all the relativistic particles considered as a fireball with $M \sim 25$ GeV/c^2 (see Proceedings of Int. Cosmic Ray Conference in Kyoto, 1961) was supplementarily analyzed. Assuming $P_\perp = 0.4$ GeV/c the 4-momenta transfers t_i between subsequently selected groups of produced particles were obtained. The maximum value of T_i is $\sim 20(\text{GeV}/c)^2$. For the comparison the similar t_i -distributions for other emulsion events at energy ~10 TeV is displayed. (auth)

10580 INELASTIC PROCESS AT THE ENERGY ABOVE 200 GeV AND THE PHASE SPACE OF EXTENDED OBJECTS. Gabunia, L. L.; Garibashvili, D. I.; Ivanova, A. B.; (and others) (Inst. of Physics, Tbilissi, USSR). pp 2278-96 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The analysis of the process of multiple production data obtained with a magnetic cloud chamber driven by the ionization calorimeter is given. Studies of single particle cross sections $d\sigma/dpe$, $d\sigma/d\cos\theta$ in the S- and C-systems, and of the correlations $d^2\sigma/dpd\cos\theta$; $d^2\sigma/dp_1 d\cos\theta$; $d^2\sigma/dp_1 d\sin\theta$; $d^2\sigma/dp_1 dp_1$ have shown that the process is determined by the phase space of extended objects. The comparison was made with the two-temperature Planck distribution, taking into account correlations between the transverse and longitudinal momenta. This distribution simulates well the properties of the phase space of extended objects. The analysis of two particle correlations has shown that studies of similar correlations may lead to finding new dynamical properties of this phenomenon. (auth)

10581 ALGEBRAIC EQUATIONS FOR BETHE-SALPETER AND COULOMB GREEN'S FUNCTIONS. Kyriakopoulos, E. (Democritos Nuclear Research Center, Athens). J. Math. Phys. (N. Y.); 13: No. 11, 1729-35(Nov 1972).

The equation for the Bethe-Salpeter Green's function in the case of two scalar quarks interacting via the exchange of a scalar particle of zero mass is transformed to an algebraic equation with the help of the dynamical group SO(5,2). From this equation a one-parameter integral representation of the Green's function is obtained in the case of maximal binding, and from this representation the Green's function is calculated in terms of a hypergeometric function. The equation for the f-dimensional nonrelativistic Coulomb Green's function is also transformed to an algebraic equation. (auth)

10582 STRUCTURE OF ELEMENTARY PARTICLES. Flamm, Dieter (Institut fuer Hochenergiephysik, Vienna). Acta Phys. Austr.; 35: No. 1-2, 40-50(1972). (In German).

A mathematical model of the structure of the hadron is presented. The model presented represents the experimental data qualitatively well. The agreement for the difference between inelastic electron-proton and electron-neutron effective cross sections is especially good. (J.S.R.)

10583 BOUND STATES IN THE STRONG-COUPLING LIMIT. Martin, Andre (CERN, Geneva). Helv. Phys. Acta; 45: No. 2, 140-8(1972).

It is shown that the number of bound states of a particle in a short-range potential in n dimensions is given asymptotically by $N = g^{n/2}[S_n/(2\pi)^n]\int |(2MV^-/\hbar^2)|^{n/2} d^n x + 0(g^{n/2-\epsilon})$ for $g \to \infty$, where gV^- is the attractive part of the potential, and S_n is the volume of the n dimensional sphere with unit radius. (auth)

10584 ALGEBRA OF VERTEX STRENGTHS AND THE LIGHT CONE. Cabibbo, N. (INFN, Rome); Testa, M. Phys. Lett.; 42B: No. 3, 369-71(11 Dec 1972).

On the basis of light cone current algebra it is shown that tensor meson trajectories couple to hadrons through the matrix elements of scalar densities. Some consequences of this fact are discussed. (auth)

10585 STRONG INTERACTIONS. National Colloquium on Theoretical Physics, Montpellier, France, May 3-8, 1971. Renard, F. M.; Sabatier, P. C. (eds.). Montpellier, France; University of Montpellier ([1971]). 350p. (In French and English). (CONF-710558).

Nine papers were presented under the following headings: analytical properties of the nonrelativistic scattering amplitude, pion-pion scattering and axiomatic results, the three-body problem, phenomenological models and analytical properties in the angular momentum complex plane, exchange degeneracy and dip mechanisms in high energy collisions, duality, introduction to axiomatic duality, highly inelastic scattering of leptons, the parton model and field theory in the framework of infinite momentum. Each paper was abstracted separately. (France)

For abstracts of individual papers see: 10506, 10507, 10562, 10586, 10602, and 10733-10736.

10586 THREE-BODY PROBLEM. Newton, R. G. (Indiana Univ., Bloomington). pp 3.1-3.31 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

Mathematical difficulties encountered in strong interaction physics involving three particles are reviewed. (France)

10587 EXCLUSIVE CROSS-SECTIONS AND THE THERMODYNAMIC MODEL. Bassetto, A. (CERN, Geneva); Ranft, G.; Ranft, J. Lett. Nuovo Cim.; 5: No. 13, 841-7(25 Nov 1972).

A method is outlined for obtaining exclusive quantities from a knowledge of moments in the thermodynamic model. Qualitative predictions are made for the exclusive cross sections. (L.B.S.)

10588 UNCERTAINTY RELATION AND PHENOMENOLOGICAL MASS OPERATOR FOR HADRONS. Ito, D.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 5: No. 13, 848-50(25 Nov 1972).

A phenomenological mass operator for hadrons is proposed, which is suggested in the proof of uncertainty relations for the internal variables of a many-body system. (L.B.S.)

10589 NEW SCALAR AND CONSERVED VECTOR CURRENTS IN DUAL-RESONANCE MODELS. Tze, H. C. (Univ. of Chicago). Lett. Nuovo Cim.; 5: No. 13, 865-72(25 Nov 1972).

A new class of dual models of scalar and vector currents is presented, starting from conformal scalar and spinor fields. The work stems from the notion that off-shell mesons (currents) are emitted from the interior of the Kova-Nielsen disc, while on-shell mesons are emitted from the unit circle. (L.B.S.)

10590 ANALYTIC SOLUTION OF THE TRUNCATED STATISTICAL BOOTSTRAP EQUATION WITH STEP-FUNCTION KERNEL. Chiu, C. B.; Johnsen, J. (Univ. of Texas, Austin). Contract AT(40-1)-3992. Phys. Lett.; 42B: No. 4, 475-8(25 Dec 1972).

Analytic expressions for the total level density, the pion multiplicity distribution and the average pion energy of the truncated statistical bootstrap equation with a step function kernel are presented. (auth)

10591 MODELS FOR HADRONIC AND LEPTONIC PROCESSES AT HIGH ENERGY. Landshoff, P. V.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Phys. Rep.; 5C: No. 1, 1-55(Oct 1972).

A review is given of (1) the theory of Regge cuts, (2) the structure of reggeon coupling functions; and (3) the field-theory approach to the parton model of deep inelastic leptonic processes. Each of the three parts is self-contained, but similar momentum-space techniques are used throughout. (auth)

10592 EXPLICIT SOLUTION OF THE INTEGRAL EQUATIONS FOR FIREBALL DECAY. Montvay, I. (CERN, Geneva). Phys. Lett.; 42B: No. 4, 466-70(25 Dec 1972).

The exact integral equations for the single particle distribution and multiplicity distribution of a decaying fireball are explicitly solved. The asymptotic behavior of the solutions for large fireball mass is shown to be the same as in the simplified model with linear decay chain. The possibility of obtaining the many-particle distributions is also discussed. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 10676 and 10704.

10593 (DESY-72/54) CHIRAL-INVARIANT FIELD THEORY AND PION-PION SCATTERING. Lehmann, H. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Sep 1972. 10p. Dep. NTIS (U. S. Sales Only).

An attempt is made to calculate the terms of fourth order in

the momenta in $\pi\pi$-scattering from the nonlinear chiral-invariant Lagrangian of pions and nucleons. Two parameters remain arbitrary in standard renormalization theory. Heuristic arguments based on the idea of minimal singularity and the technique of superpropagators lead to values which are in qualitative agreement with empirical information. (auth)

10594 MESON MASS RESONANCES PREDICTED BY A DIATOMIC-MOLECULE-TYPE $SU_6 \times O_3$ QUARK MODEL IN THE REGION 1 to 3 GeV. La Camera, M.; Watachin, A. (Univ., Genoa). Lett. Nuovo Cim.; 5: No. 5, 382-4(30 Sep 1972).

The part of the quark-antiquark interaction which is invariant under $SU(6) \times O(3)$ is taken to be a harmonic-oscillator potential as in the case of diatomic molecules. It is shown that, even in the simplest case when the equation which governs the internal motion of the quark-antiquark system in the Schroedinger equation, the first orbital excitations give the meson mass resonances in the 1- to 3-GeV region. (L.B.S.)

10595 UNITARITY SUM RULES AND SOFT-PION AMPLITUDES. Rosenzweig, C.; Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Nuovo Cim.; 12A: No. 2, 409-24(21 Nov 1972).

Unitarity bounds on scattering amplitudes are examined by using "unitarity sum rules" at high energy. Threshold conditions emerge when certain mass parameters approach zero. For $\pi\pi$ scattering a bound similar to (but somewhat weaker than) the Adler condition is shown to be needed in order to avoid a dangerous mass (infra-red) singularity. A different argument, which uses crucially the pseudoscalar nature of the pion and a few very plausible dynamical assumptions, yields a stronger bound as well as the possibility of extension to general pion amplitudes. The results are discussed as well as the possibility of understanding spontaneously broken symmetries from general S-matrix principles. (auth)

10596 BOUNDS WITH d-WAVE SCATTERING LENGTH. Dita, P. (Inst. of Physics, Bucharest). Nuovo Cim.; 12A: No. 2, 442-50(21 Nov 1972).

Bounds on the s-wave scattering length and s-wave amplitude in terms of the d-wave scattering length are derived. With the present estimates for the d-wave scattering length some known results are improved. (auth)

10597 INTERMEDIATE RESONANCES IN HADRON SCATTERING. APPLICATION OF THE THEORY OF INTERMEDIATE NUCLEAR RESONANCES. Takeda, G. (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1252-66(Oct 1972).

Experiments using missing mass spectrometers and bubble chambers have shown the existence of quite a large number of boson resonances. Some of these resonances might correspond to some kind of intermediate resonances or structures similar to those found in nuclear reactions at intermediate energies. The possible occurrence of such intermediate resonances in hadron scattering and their qualitative properties are discussed. (auth)

10598 THRESHOLD THEOREM ON $\pi-$HADRON AND $\pi-$NUCLEUS SCATTERING. Seki, R. (California State Univ., Northridge). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1244-51(Oct 1972).

A threshold theorem previously discussed by Oleson and Pietschmann on $\pi-$N scattering is extended to $\pi-$hadron scattering in general, including $\pi-\pi$ scattering. In a comprehensive manner the $\pi-$hadron and $\pi-\pi$ scattering lengths obtained previously by the PCAC technique are recovered. The method to obtain the threshold theorem is also applied to $\pi-$nucleus systems: A new sum rule on the $\pi-$nucleus scattering length and a relation between the $\pi-$nucleus effective coupling constant and the $\pi-$N coupling constant are derived. (auth)

10599 AVERAGE NONLINEAR DUALITY AND THE POMERON FOR TWO-BODY AND INCLUSIVE PROCESSES. Balazs, L. A. P. (Purdue Univ., Lafayette, IN). Phys. Lett.; 42B: No. 2, 276-8(27 Nov 1972).

A simple scheme combining duality with unitarity is applied to exotic $\pi\pi$ and π-Reggeized-ρ scattering. The resulting $\rho\rho$P triple-Regge vertex is in agreement with recent fits to inclusive cross sections. An extension to nonexotic channels is also discussed. (auth)

10600 PHENOMENOLOGICAL MASS OPERATOR FOR HADRONS. I. Ito, D.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 5: No. 15, 998-1000(9 Dec 1972).

A simple phenomenological mass operator is proposed which leads to the same slope of the meson and baryon trajectories as does a previous symmetric quark model. Invariant form factors are also found. (J.F.P.)

10601 MULTIBODY PRODUCTION AT MEDIATE ENERGY. Shuryak, E. V. (Inst. of Nuclear Physics, Novosibirsk, USSR). Phys. Lett.; 42B: No. 3, 357-60(11 Dec 1972).

The Pomeranchuk model is used for the calculation of the production rate of reaction channels. The thermodynamical approach to phase space calculation leads to a simple approximate formula. The results are compared with experimental data on the low energy annihilations $p\bar{p} \to n\pi$, $K\bar{K}n\pi$. (auth)

10602 PION–PION SCATTERING AND AXIOMATIC RESULTS. Martin, Andre (European Organization for Nuclear Research, Geneva). pp 2,1-2,35 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

The following subjects are considered: analytical properties of scattering amplitudes (classical results in the on-mass shell analyticity region, positivity and unitarity, extension of the analytical region by positivity, consequences of the new analytical region), limits at all energies, conditions for pure crossing with partial waves, and crossing conditions and positivity. (France)

10603 EXISTENCE OF CROSSING-SYMMETRIC AND UNITARY AMPLITUDES IN S-MATRIX THEORY. Atkinson, D. (Univ., Bonn). Fields Quanta; 3: No. 2, 193-239(Oct 1972).

It is shown that the Mandelstam equations for the $\pi\pi$ system have many solutions, consistent with crossing symmetry and elastic unitarity. A subset of these solutions is shown to satisfy the inelastic constraints above the inelastic threshold. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 10483 and 10693.

10604 (CONF-720219–, 99-128) K^+–NUCLEON INTERACTIONS BETWEEN 0,6 AND 1,5 GeV/c. Castelli, E. 1972.

From Proceedings of the triangle seminar; Budapest, Hungary (9 Feb 1972).

In the last years the K^+-nucleon interaction has been studied extensively by the B–G–R–T Collaboration with two bubble chamber experiments in which the K^+-proton and K^+-deuterium interactions were observed. These data were used for a phase-shift analysis of the K^+-nucleon system in the I = 1 and I = 0 states. The work of the B–G–R–T Collaboration is presented. It includes the data collected up to now and the results of the phase-shift analysis. (auth)

10605 (UCR-34-P-107-A-X-1) ANNUAL REPORT [ON HIGH-ENERGY PHYSICS], SEPTEMBER 1, 1970–FEBRUARY 1, 1972. Kaus, P. E.; Desai, B. R. (California Univ., Riverside). 1972. Contract AT(04-3)-34. 5p. Dep. NTIS.

Research on the Veneziano representation and complex Regge poles for strong interactions is summarized. (J.F.P.)

10606 LARGE ANGLE BEHAVIOR, MULTIPLE SCATTERING, AND REGGE CUT WITH URBARYON LINE DIAGRAM. Nakamura, Fumihiko (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1267-79(Oct 1972).

The usefulness of Regge cut models has recently been examined but its definition has much ambiguity. A Regge cut derived from the assumption of a multiple scattering mechanism is examined in terms of urbaryon line diagrams for hadron reactions for the composite particle reaction. The urbaryon-line-diagram scheme is compared with the Feynman-diagram one in the case of Regge cuts and look at the difference between them in large-angle scattering. Assuming the unitarity relation for the urbaryon-line diagram, it is examined how urbaryons behave in the multiple scattering mechanism, when the selection rule of the third double spectral function for the Regge cut is applied to urbaryon cut diagrams. (auth)

10607 DISPERSION RELATIONS AND EXPERIMENTAL DATA. Pietarinen, E. (NORDITA, Copenhagen). Nuovo Cim.; 12A: No. 2, 522-31(21 Nov 1972).

A substitute for phenomenological dispersion relations is proposed. The method uses expansion of the scattering amplitude in terms of analytic functions. The convergence and stability of the expansion are ensured by a prior probability measure on the expansion coefficients. The method is applied to the πN scattering amplitudes. (auth)

10608 INVESTIGATION OF ENERGY FRAGMENTATION DISTRIBUTIONS. Biebl, K. J.; Gensch, U.; Schreiber, H. J. (Institut fuer Hochenergiephysik, Berlin). Phys. Lett.; 42B: No. 2, 221-3(27 Nov 1972).

Energy fragmentation distributions in inclusive reactions, $((E \pm p_L)^* d^3\sigma/d^3p)$, and their momentum integrals yielding the

energy fragmentation fractions of Chou and Yang are considered in 16 GeV/c π^-p interactions. (auth)

10609 EVIDENCE FOR REGGE SHRINKAGE IN π EXCHANGE. Estabrooks, P.; Martin, A. D. (CERN, Geneva). Phys. Lett.; 42B: No. 2, 229-32(27 Nov 1972).

The possible ways of determining the Regge behavior of π exchange from the data are reviewed, and it is concluded that the most reliable way is to study ρ^H_{00} dσ/dt for π^-p $\rightarrow \rho^0$n. Using such data evidence is found for a pion trajectory of conventional Regge slope. The pion trajectory is also isolated using data for γp $\rightarrow \omega$p. (auth)

10610 PROTON STRUCTURE AND HYPERFINE SPLITTING IN THE HYDROGEN ATOM. Gnaedig, P. (Eoetvoes Univ., Budapest); Kuti, J. Phys. Lett.; 42B: No. 2, 241-5(27 Nov 1972).

Lower and upper bounds on the proton polarizability contribution to the hyperfine splitting in atomic hydrogen are calculated from positivity conditions and sum rules on spin-dependent inelastic electron-proton scattering. Discussion of the underlying assumptions and some remarks on the Rafael's closely related work are presented. (auth)

10611 ABSORPTION MODEL AMPLITUDE ANALYSIS FOR THE REACTION π^-p $\rightarrow \pi^-\pi^+$n AT 17.2 GeV/c. Kimel, J. D.; Reya, E. (Florida State Univ., Tallahassee). Phys. Lett.; 42B: No. 2, 249-52(27 Nov 1972).

The absorptive OPE model readily explains the recent amplitude analysis of the π^-p $\rightarrow \pi^-\pi^+$n CERN-Munich experiment at 17.2 GeV/c if the full helicity dependence of absorption corrections is included. No evidence for appreciable A_2-exchange in the forward direction is found. (auth)

10612 BACKWARD π^-p ELASTIC SCATTERING AT 3 AND 4 GeV/c. Brabson, A. (Istituto Nazionale di Fisica Nucleare, Padua); Calvelli, G.; Cittolin, S.; (and others). Phys. Lett.; 42B: No. 2, 283-6(27 Nov 1972).

Measurements were made of dσ/du for π^-p elastic scattering at 3 and 4 GeV/c in the ranges $-0.119 \leq u \leq 0.113$ and $-0.233 \leq u \leq 0.088$, respectively. A fit of the form $d\sigma/du = A \exp(Bu + Cu^2)$ gives $B = 4.34 \pm 0.42$ and $C = 7.0 \pm 3.5$ at 4 GeV/c with $\chi^2 = 5.7$ for 9 degrees of freedom; the simpler form $d\sigma/du = A \exp(Bu)$ gives $B = 3.7 \pm 0.3$ with $\chi^2 = 9.6$. At 3 GeV/c the structures already observed are confirmed with high statistics. (auth)

10613 PERIPHERAL ABSORPTION MODEL FOR π^-p CHARGE EXCHANGE SCATTERING. Takaya, Y. (Meteorological Coll., Kashiwa, Japan); Kenmoku, M. Progr. Theor. Phys. (Kyoto); 48: No. 4, 1408-10(Oct 1972).

A model of peripheral absorption is proposed in which it is asserted that the range of the interactions whose quantum numbers in the t-channel are different from those of vacuum must be peripheral. It is shown that this assertion is good for the π^-p charge-exchange reaction. It is suggested that the model can be easily extended to other reactions. (L.B.S.)

10614 CAUSALITY-VIOLATION AT HIGH ENERGIES. Kawamoto, Noboru (Tokyo Inst. of Tech.); Sekine, M. Progr. Theor. Phys. (Kyoto); 48: No. 4, 1423-4(Oct 1972).

Recent Brookhaven Coulomb-interference experiments demonstrated the validity of the usual dispersion relations up to at least 20 GeV/c laboratory momentum. It was concluded from these results that if microscopic causality is violated, this occurs at distances less than 10^{-15} cm. It is shown that the present Brookhaven experiments are favorable to causality violation at a distance $a_0 = 0.6 \times 10^{-13}$ cm using the once-subtracted dispersion relation and taking into account newly measured πN total cross sections. (L.B.S.)

10615 CHOICE OF INVARIANT AMPLITUDES FOR THE VECTOR-MESON DOMINANCE MODEL IN ρ^0N $\rightarrow \pi$N. Kroll, P. (Univ., Karlsruhe, Ger.); Meyer, S. Lett. Nuovo Cim.; 5: No. 14, 889-94(2 Dec 1972).

Two sets of invariant amplitudes for the process $\rho^0 + N \rightarrow \pi + N$ are discussed. These amplitudes fulfill the given conditions but give different results for the relations between the longitudinal and transverse s-channel helicity amplitudes. The general validity of these relations is discussed. (J.F.P.)

10616 MODEL-INDEPENDENT ANALYSIS OF THE ROLE OF PION EXCHANGE IN π^-p INTERACTIONS AT 11.2 GeV/c. Antich, P. P.; Cecchet, G.; Ratti, S.; Rivosecchi, R. (Univ., Milan). Lett. Nuovo Cim.; 5: No. 14, 941-6(2 Dec 1972).

Qualitative agreement with the presence of a dominant pion exchange contribution to the reactions $\pi^- + p \rightarrow p(n) + 2\pi^- + \pi^+(2\pi^+)$ and $\pi^- + p \rightarrow p + 2\pi^- + \pi^+ + \pi^0$ at 11.2 GeV/c, in which a strong ρ^0 signal is seen, is found from a model-independent analysis both by comparing off- with on-mass shell data for the ratios of cross sections and some angular distributions and by considering the spin density matrix elements of the produced ρ^0. The data indicate two alternative conclusions concerning the amplitude: either the lack of factorization is all included in the apparent anisotropy of the Treiman-Yang distribution or the cross sections are factorizable at least in a first approximation. (J.F.P.)

10617 FINITE-ENERGY SUM RULES IN K$^-$p $\rightarrow \pi^+\Sigma^-$ AND π^-p $\rightarrow$ K$^+\Sigma^-$. Pajares, C. (Laboratoire de Physique Theorique et Particules Elementaires, Orsay, France); Pascual, R. Lett. Nuovo Cim.; 5: No. 15, 985-90(9 Dec 1972).

The finite-energy sum rules are computed for the $K^- + p \rightarrow \pi^+ + \Sigma^-$ and $\pi^- + p \rightarrow K^+ + \Sigma^-$ interactions in order to find deviations from a pure Regge pole behavior. It is found that there is evidence of a violation of the pure Regge behavior which cannot be due only to a Regge-Regge cut effect, but could be a fixed pole. (J.F.P.)

10618 REFORMULATION OF THE πN STATIC MODEL. Greenman, J. V. (Univ. of Helsinki). Lett. Nuovo Cim.; 5: No. 6, 525-8(7 Oct 1972).

The question of the existence of solutions to the πN static model is considered. It is determined what are the features of this model that are not found in the charged scalar model and that cause the breakdown of the fixed-point theorems at extremely small values of the coupling constant. The basic idea is to incorporate as much information as possible in the Low equation before attempting to apply nonlinear methods to analyze the equation. Three transformations allow one to incorporate into the equation the information that the solution possesses resonance poles and zeros at certain positions and the fact that the signs of the coupling constants are crucial to the analysis. (J.F.P.)

10619 METHOD FOR THE DETERMINATION OF DENSITY MATRIX ELEMENTS AND AMPLITUDES OF ONE-PION EXCHANGE REACTIONS. Ochs, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim.; 12A: No. 3, 724-36(1 Dec 1972).

Due to the lack of experiments with polarized protons a complete amplitude analysis of OPE-dominated quasi-two-body reactions is not possible. A method for an analysis is discussed making additional assumptions. Motivated by the absorption model it is assumed that the s-channel nucleon flip amplitudes dominate and that the phases of the helicity amplitudes do not depend on the helicities. The assumptions are shown to be sufficient to determine the production amplitudes. Some weaker assumptions are sufficient to determine the unmeasurable part of the density matrix. Relations between the measured moments of the angular distributions are derived. The method may be applied to the determination of meson-meson phase shifts. (auth)

10620 PROBLEM OF RESONANCE SELECTION IN THE SECOND ($\frac{1}{2}^+$) AND ($\frac{3}{2}^-$) MULTIPLETS. Kostyrko, I. I. (Inst. of Mathematics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 376-9(Mar 1972). (In Russian).

Formulas are obtained to determine the decay widths of the second ($\frac{1}{2}^+$)- and ($\frac{3}{2}^-$)-octets within the terms of the Rarita-Schwinger formalism. Analysis of probability of these multiplets was made on the basis of comparison of theoretical and experimental data on the decay widths. It is shown that the selection of the resonances performed earlier with the allowance for the decay width analysis was unsuccessful. (auth)

10621 INTERFERENCE TERMS IN THE MULTIPERIPHERAL MODEL. Amann, R. F.; Shah, P. M. (Syracuse Univ., NY). Phys. Lett.; 42B: No. 3, 353-6(11 Dec 1972).

The customary assumption of the neglect of interference or crossed graph terms is investigated within a simple multiperipheral model and found to be completely unjustified. The inclusion of these terms, in a multi-Regge model, allows the correct prediction of the ratio of Kp to πp cross sections and of the energy dependences of inelastic cross sections and pion multiplicities. A natural explanation is provided for dramatic structures observed in correlation functions. (auth)

10622 SHACKLES ON LINEAR ABSORPTION MODELS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Phys. Lett.; 42B: No. 4, 479-85(25 Dec 1972).

The fundamental constraints that all Linear Absorption Models must possess, independent of the rescattering amplitude are examined. These constraints are most direct in impact parameter space, where the rescattering appears simply as a multiplicative factor. It is a crucial test of such models that the ratio of two exchanges—for example vector and tensor exchanges—is completely specified in b-space by the ratio of input Regge pole amplitudes. Amplitude analysis exists for vector ρ exchange, in π^-p $\rightarrow \pi^0$n. Lacking experimental A_2 tensor amplitudes, the Linear Absorption Models constraint are used to calculate A_2 exchange from ρ input, and the results are compared with π^-p $\rightarrow \eta^0$n data. Both simplicity and duality assumptions for Regge pole couplings are

considered. The results suggest that the Linear Absorption Models constraint is not fully consistent with data. (auth)

10623 DUALITY IN EXOTIC PEAKS. Igi, K. (Rockefeller Univ., New York); Eguchi, T. Contract AT(11-1)-3232. Phys. Lett.; 42B: No. 4, 449-52(25 Dec 1972).

A simple s-channel resonance model based on duality is proposed to explain: (a) the appearance of distinct exotic peaks, and (b) the sharp fall-off of exotic cross sections versus energy, recently observed in K^-p and $\bar{p}p$ backward scattering. (auth)

10624 NOTE ON THE USE OF THE NEW VARIABLE n^2 FOR ELASTIC SCATTERING AND INCLUSIVE REACTIONS. Narayan, D. S. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 42B: No. 4, 439-43(25 Dec 1972).

The usefulness of the kinematical variable n^2 which has been proposed in connection with elastic scattering and inclusive reactions is examined in the context of a certain historical background which already exists, and a modification to the proposed formulas is presented. (auth)

10625 UNIVERSAL CURVE FOR MESON–NUCLEON ELASTIC SCATTERING. Blaha, S.; Pardee, W. J.; Sukhatme, U. P. (Univ. of Washington, Seattle). Phys. Lett.; 42B: No. 4, 435-8(25 Dec 1972).

All available high energy meson-nucleon differential elastic cross-section data are plotted against a simple kinematic variable and it is shown that forward and backward region data fall on a universal curve. Some consequences are discussed, including predictions at NAL energies. (auth)

10626 ENERGY DEPENDENCE OF CROSS SECTIONS FOR REACTIONS PRODUCING PIONS IN A SIMPLE MULTIPERIPHERAL MODEL. Perilae, P. (Univ. of Helsinki). Phys. Scr.; 5: No. 6, 233-6(1972).

The energy dependence of the cross sections for pion producing channels in pp and πp collisions has been compared with the prediction of a simple multiperipheral model with exponential dependence on momentum transfers t_i. A reasonable agreement has been found in most of the channels studied. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 10368, 10478, 10490, and 11040.

10627 (BNL-tr-508) EMPIRICAL FORMULA FOR PION AND KAON SPECTRA IN P-P COLLISIONS. Folomeshkin, V. N. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 15: No. 2, 383-91(1972). 21p. Dep. NTIS.

An empirical formula is proposed which describes the spectra of pions and kaons produced in pp-interactions in a wide range of angles ($0 \le \theta \le 2\pi$) and momenta ($0 \le p \le p_{max}$) of the secondary particles. The formula has a form $d\sigma = A\Phi_1\Phi_2\Phi_3\Phi_4 d^3p/E$. A function $\Phi_1 = (1 - F)\exp(-Bp_1^2) + F\exp(-Gp_1^2)$ describes the dependence of the cross section on the transverse momentum. A function $\Phi_2 = \exp(-p^*/(D\sqrt{s}))$ describes the main dependence of the spectrum on the longitudinal momentum. A cutoff $\Phi_3 = (1 - p^*/p^*_{max})^N$ determines the spectrum behavior at the upper kinematical limit. And finally a multiplier $\Phi_4 = \Phi - \exp(-sp^{*2}/T - p_1^2/H)$ describes details of the spectrum behavior in the lowest momentum and angle region. (auth)

10628 (JINR-E2-6718) ON THE RADIUS OF NN AND πN INTERACTIONS. Stavinskii, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 8p. Dep. NTIS (U. S. Sales Only).

The analytical bounds of the experimentally measured total cross sections, the slope parameter, and the real part of the scattering amplitude are obtained. (auth)

10629 (JINR–P1-6693) ELASTIC $\pi^+\alpha$-SCATTERING IN THE REGION OF THE Δ_{33} RESONANCE. Kulyukin, M. M.; Lyashenko, V. I.; Mikhul, A.; Nikitiu, F.; Piradzhino, G.; Pontekorvo, D. B.; Falomkin, I. V.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

A phase-shift analysis was performed over the experimental data on π ^{4}He-scattering in the energy region 20 to 150 MeV. The phase dependence on the energy was found. The phase behavior reveals the resonance character in the region ≈140 MeV. (auth)

10630 (NP–19603) INTERACTION OF HIGH ENERGY PARTICLES WITH DEUTERONS (A REVIEW). Kolybasov, V. M.; Marinov, M. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 36p. (In Russian). Dep. NTIS (U. S. Sales Only).

The subject of the review is a comparison of available experimental data on interactions of high energy particles with deuterons with the theoretical predictions based on the conception of diffractional character of the interactions. The Glauber correction of the total cross sections due to the deuteron structure is considered, and the information on the deuteron form factor obtained from the elastic electron–deuteron scattering is used. The theory is also compared with the data on angular distributions in elastic pd, πd and $\bar{p}$d scattering, as well as for the inelastic pd scattering. Corrections to the Glauber theory arising from the virtual particle production at high energies (inelastic screening) are considered. A brief review of basic assumptions of the Glauber theory is given in conclusion and the accuracy of the theoretical predictions is discussed. (auth)

10631 ANALYSIS OF THE p- AND s–d- SHELL Λ-HYPERNUCLEI. Khrylin, B. A.; Kochetov, A. V. (Inst. of Atomic Energy, Moscow). Phys. Lett.; 42B: No. 1, 38-40(13 Nov 1972).

The binding energies of the p- and s–d-shell Λ hypernuclei are discussed in terms of the central two-body ΛN potentials and ΛN Majorana forces. (auth)

10632 ANOMALOUS DIMENSIONS IN p-p ELASTIC SCATTERING? Theis, W. R. (DESY, Hamburg). Phys. Lett.; 42B: No. 2, 246-8(27 Nov 1972).

The concept of anomalous dimensions is used to connect high energy, large angle elastic p–p scattering with the high momentum behavior of the proton electromagnetic form factor consistent with the existing data. (auth)

10633 SHADOW AND ANTISHADOW EFFECTS IN THE SCATTERING OF PARTICLES ON THE DEUTERON. Anisovich, V. V.; Volkovitskii, P. E.; Dakhno, L. G. (Inst. for High Energy Physics, Serpukhov, USSR). Phys. Lett.; 42B: No. 2, 224-8(27 Nov 1972).

The shadow effects due to the inelastic rescattering of any incident particle on the nucleons of the deuteron are discussed. An empirical expression that takes into account the inelastic rescattering is proposed for the Glauber correction. (auth)

10634 RECOIL FORM FACTOR FOR THE DEUTERON. Namyslowski, J. M. (Univ., Warsaw). Nuovo Cim.; 12A: No. 2, 331-40(21 Nov 1972).

Making an eikonal approximation in two relative momenta in a 3-body system, keeping trace of all recoil terms, and assuming that the ranges of forces responsible for πp and πn elastic scattering are small, the following form factor is found for the double-scattering term in $\pi d \to \pi d$:

$$\left[1 + \left(\frac{\Delta\mu}{4kM}\right)^2\right]^{-4} \left\langle \frac{1}{\rho^2} \exp\left[i\rho\left[\frac{\Delta^2}{8k}\left(1 + \frac{\mu}{2M}\right) - \frac{\mu B}{k}\right]\right] \cos\left(\rho\,\frac{\Delta^2\mu}{8kM}\right)\right\rangle_d$$

where $q \equiv r[1 + (\Delta\mu/4kM)^2]^{-4}$, B is the binding energy of the deuteron, μ, M are pion and nucleon masses, respectively, Δ is the momentum transfer in the $\pi d \to \pi d$ process. The above form factor should be compared with the ordinary one of Glauber $\langle 1/r^2\rangle_d$ and with the form factor of Blankenbecler and Gunion, and Gottfried $\langle 1/r^2 \exp[ir\eta]\rangle_d$, where $\eta \equiv \Delta^2/8k$. auth

10635 PHENOMENOLOGICAL CONSEQUENCES OF ARNOLD AND BARNETT'S SHIELDING-CUT MECHANISM IN PROTON–PROTON DIFFRACTION SCATTERING. Fujisaki, H.; Akiba, E. I. (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1294-1307(Oct 1972).

Phenomenological consequences of Arnold and Barnett's shielding-cut (ABSC) mechanism are investigated. Under the assumption of an effective normal-Regge trajectory of exchange-degeneracy breaking, the presently available data on p-p diffraction scattering at high energies are analyzed by the use of the fixed simple-pole Pomeron (FSPP) with and without ABSC mechanism. First, the presently existing data on the total cross section can be successfully explained by FSPP without ABSC mechanism and also by FSPP with two ABSC $\bar{\alpha}_C(t) = 1 - m_\pi^2 + t/4$ and $\bar{\alpha}_C(t) = 1 - m_K^2 + t/4$, but do not seem to be satisfactorily fitted by FSPP with an ABSC $\bar{\alpha}_C(t)$ alone. Secondly, the data on the real to imaginary ratio of the forward amplitude can be reasonably (but not very successfully) fitted by FSPP without ABSC and also by FSPP with two ABSC $\bar{\alpha}_C(t)$ and $\bar{\alpha}_C(t)$, but do not seem to be consistently explained by FSPP with an ABSC $\bar{\alpha}_C(t)$ alone. Thirdly, FSPP with two ABSC $\bar{\alpha}_C(t)$ and $\bar{\alpha}_C(t)$ can give a fully successful explanation of all the existing data on the slope parameter of the elastic peak without the aid of normal-Reggeon contribution. This best fit is obtained by the use of the only one adjustable parameter. But, either FSPP without ABSC or FSPP with an ABSC $\bar{\alpha}_C(t)$ does not seem to give a consistent fitting to the presently available data on the slope. On the basis of these observations, it is argued that the presently available data on p-p diffraction scattering seem to prefer FSPP with two ABSC $\bar{\alpha}_C(t)$ and $\bar{\alpha}_C(t)$ rather than FSPP without ABSC and FSPP with an ABSC $\bar{\alpha}_C(t)$ alone. (auth)

10636 PRODUCTION RATES AND DISTINCTIVE COMPONENTS OF SINGLE-PARTICLE DISTRIBUTIONS. III. INCLUSIVE REACTIONS AND URBARYON REARRANGEMENT DIAGRAMS. Kinoshita, K.; Noda, H. (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1280-93(Oct 1972).

The production mechanism of a particle in multi-particle production is distinguished according to whether it is composed of urbaryons coming partly from incident particles, or is composed only of ones newly created in the collision. The former mechanism, which is different for a particle and its antiparticle, gives constant multiplicity and rapid limiting behavior in the fragmentation region. In the case of pp collisions, the limiting energy for this mechanism is somewhat above 10 GeV/c. The latter mechanism gives the same increasing multiplicity and distribution for a particle and its antiparticle. The scaling energy in the latter mechanism including $x \approx 0$ is quite different for π, K and $\bar{p}$, indicating strong mass dependence. The scaling energies in the reactions $pp \to \pi^- X$, $K^- X$ and $\bar{p}X$ are around 30 GeV/c, a few hundred GeV/c and 1 TeV/c, respectively. It is conjectured that the average multiplicity differences such as $\bar{n}_{\pi^+} - \bar{n}_{\pi^-}$, $\bar{n}_{K^+} - \bar{n}_{K^-}$ become energy independent at energies somewhat above 10 GeV/c for pp and K^+p collisions. (auth)

10637 BINDING ENERGIES OF DOUBLE HYPERNUCLEI AROUND A = 10 AND $\Lambda-\Lambda$ INTERACTION PARAMETER. Iwao, S.; Shako, M. (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1412-14(Oct 1972).

A model for explaining the binding energies of single hypernuclei by the Weizacker–Bethe mass formula is extended to the binding energies of unobserved double hypernuclei. The mass parameters and the predicted binding energies for double hypernuclei around A = 10 are tabulated. (L.B.S.)

10638 ELASTIC NUCLEON–DEUTERON SCATTERING. Polozov, A. D.; Fursa, A. D. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 439-47(Mar 1972). (In Russian).

On the basis of the multipole formalism, the elastic scattering of the high energy nucleons by a deuteron is considered. The nucleon–deuteron scattering amplitude is expressed through the nucleon–nucleon scattering amplitude and the form factors connected with the deuteron structure. Two-nucleon scattering amplitude and deuteron wave function are found by solving the two-particle problem with the Tabakin potential. The cross section and polarization formulas are obtained, taking into account a pick-up term and D-wave in the ground-state wave function of the deuteron. The obtained results are in good agreement with the experimental data of cross section and polarization. (auth)

10639 NON-SINGULAR, LOCAL $^1S_0$ NEUTRON–PROTON POTENTIAL. Kermode, M. W. (Univ. of Liverpool). J. Phys., A (London); 5: No. 11, L125-7(Nov 1972).

A nonsingular, local $^1S_0$ n-p potential is introduced. This potential gives phase shifts for n-p scattering which agree, within experimental error, with the experimental phase shifts. (auth)

10640 MODEL FOR THE POMERON TRAJECTORY. Cohen-Tannoudji, G. (CEN, Saclay, France); Ilyin, V. V.; Enkovskii, L. L. Lett. Nuovo Cim.; 5: No. 14, 957-62(2 Dec 1972).

A model for the Pomeron trajectory is shown to have many attractive features and to fit all existing experimental data on differential cross sections for p + p elastic scattering at high energies. (J.F.P.)

10641 EFFECTIVE REGGE TRAJECTORY FOR $pp \to d\pi$. Dubal, L. (National Research Council of Canada, Ottawa). Lett. Nuovo Cim.; 5: No. 15, 978-80(9 Dec 1972).

An attempt was made to extract the effective Regge trajectory from the timelike $u = +0.08$ (GeV/c)^2 to the spacelike $u = -2.1$ (GeV/c)^2 region for $pp \to d\pi$ interactions at 4 to 24 GeV/c. The differential cross sections were evaluated with a smooth hand-drawn curve through the experimental data. (J.F.P.)

10642 FERMI MOTION AND DEUTERON RECOIL IN RELATIVISTIC, COVARIANT, EIKONAL FORMALISM. Namyslowski, J. M. (Univ., Warsaw). Lett. Nuovo Cim.; 5: No. 15, 991-7(9 Dec 1972).

The relativistic, covariant, eikonal formalism based on the Weinberg infinite-momentum dynamics and the Todorov quasi-potential approach is extended to include motion of all particles involved in the process $\pi d \to \pi d$. (J.F.P.)

10643 ROLE OF π IN HIGH-ENERGY n-p CHARGE EXCHANGE. Glueck, M. (Univ., Marburg, Ger.). Phys. Rev. Lett.; 29: No. 26, 1762-4(25 Dec 1972).

The forward peak in n-p charge-exchange reactions is accounted for by a simple Born model. The value of the peak is shown to be due to u-channel π^0 exchange, whereas its shape is found to be determined by the interference between the above mentioned π^0 contribution and a π^+ exchange in the t channel. The agreement with the data is fairly good for all incident momenta above 3 GeV/c and for a range of momentum transfer $0 < |t| < 0.005$ (GeV/c)^2. (auth)

10644 HEAVY NUCLEUS NUCLEON COLLECTIVE INTERACTIONS OF HIGH ENERGY COSMIC RAYS. Grigorov, N. L.; Zhuravlev, D. A.; Kozlov, V. D.; (and others) (Moscow State Univ.). pp 2229-33 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The hypothesis that heavy cosmic nuclei reactions with target nuclei are the result of the independent interactions of incident nucleons in nuclei with the target nucleus is tested. For this test the π^0 production efficiency is compared in nucleon–nucleus interactions for nucleons both free and bound in the nucleus. (J.F.P.)

10645 CLASSIFICATION OF INELASTIC INTERACTIONS AT HIGH ENERGIES. Lebedev, A. M.; Slavatinskii, S. A.; Zelevinskaya, N. G. (Lebedev Inst. of Physics, Moscow). pp 2307-16 of 12th International Conference on Cosmic Rays. Vol. 6. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.6).

The values of four-momenta transferred from one group of particles produced in nucleon-quasi-nucleon interactions to another and their correlations were analyzed. The method gives a possibility to classify individual interactions according to available theoretical models of multiple production. It is shown that in ~50% of inelastic interactions at 250 GeV obtained at Tien-Shan station one meson cluster (fireball) with mass equal to 3 to 4 GeV is produced and this fireball decays according to statistical theory. (auth)

10646 DIFFRACTION GENERATION OF PARTICLES BY 21-GeV PHOTONS ON THE NUCLEI IN PHOTOEMULSION. Azimov, S. A.; Gulyamov, U. G.; Chernova, L. P.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 10, 22-4(1971). (In Russian).

The diffraction coherent generation of pions by the reaction of protons with momentum = 20.8 GeV/c with photoemulsion nuclei was studied in a strong magnetic field (H = 180 kilo-oersteds). Evidence was found for the following products of the p + nucleus reaction: nucleus + $p\pi^+\pi^-$, nucleus + $p\pi^+\pi^-$ ($m\pi^0$), nucleus + $n\pi^+\pi^+\pi^-$ ($m\pi^0$), and nucleus + $p2\pi^+2\pi^-$. (K.S.W.)

10647 MULTIPLICITY MOMENTS AND TRANSVERSE MOMENTUM DISTRIBUTIONS FROM A SIMPLE GEOMETRIC MODEL OF HADRON–HADRON COLLISIONS AT HIGH ENERGIES. Barshay, S. (Univ. of Copenhagen). Phys. Lett.; 42B: No. 4, 457-60(25 Dec 1972).

From a geometric picture of p-p collisions, a simple formula is obtained for the moments of the multiplicity distribution for pions, $\langle n^\alpha \rangle / \langle n \rangle^\alpha = 2^\alpha/(\alpha + 1)$. This describes the empirically near-constant moments of the charged prong distribution between 50 and 300 (GeV/c), for $\alpha = 2$ to 8. The model can yield the following further results for p-p collisions: (1) $d\sigma_{el}/dt \propto \exp(-14|t|)$ at small $|t|$, with a diffraction minimum near $|t| \approx 0.56$ (GeV/c)^2; (2) $d\sigma_{el}/dt \propto |\sum_{n=1}^{\infty} A_n \exp(-7\sqrt{s}/n)|^2$ at $\theta \approx 90°$; (3) near x = 0, $E_\pi(d^3\sigma_\pi/dp_\pi) \propto |\sum_{n=1}^{\infty} B_n \exp(-2p_\perp/n)|^2$. (auth)

10648 EXTENSIVE AIR SHOWERS AND FEYNMAN SCALING ABOVE 1000 GeV. Gaisser, T. K.; Maurer, R. H. (Franklin Inst., Swarthmore, PA). Phys. Lett.; 42B: No. 4, 444-8(25 Dec 1972).

A method is described for using extensive air shower data to determine whether a Feynman scaling limit exists in the central region for inclusive cross sections. Preliminary analysis suggests that the shower muon to electron ratio is more consistent with a power law increase of pion multiplicity with energy than with the logarithmic multiplicity increase characteristic of a scaling limit, but an analysis of the intra-nuclear cascade is required to reach a firm conclusion. (auth)

10649 EVALUATION OF SCALING IN LARGE ANGLE pp ELASTIC SCATTERING. Barger, V.; Halzen, F.; Luthe, J. (Univ. of Wisconsin, Madison). Phys. Lett.; 42B: No. 4, 428-30(25 Dec 1972).

In disagreement with previous claims no convincing indication is found for fixed angle scaling in the existing pp elastic scattering data. The scaling relation $d\sigma/dt = s^{-n} F(\cos\theta)$ is approximately

valid with $n \approx 9.3$ for low and intermediate energy data with $\theta \geq 70°$. However, high energy data have a more rapid energy dependence ($n \approx 10$) and the corresponding n values vary with θ. An analysis of the data at fixed t in terms of an effective Regge trajectory is also performed. (auth)

10650 SPECTRA OF PARTICLES AND ANTIPARTICLES IN THE CENTRAL REGION. Gendenshtein, L. E.; Kaidalov, A. B. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 16: No. 4, 174-8(20 Aug 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 4, 249-53(20 Aug 1972).

The behavior of the spectra of p and $\bar{p}$ produced in pp inclusive interactions in the central region is discussed in terms of the multiperipheral model. A mechanism that explains the difference in the yields of p and $\bar{p}$ at energies up to 10^3 GeV is discussed, which in turn makes it possible to describe the spectra. The mechanism is based on the contribution of backward pion-nucleon scattering to the cross section for proton production. (L.B.S.)

10651 POMERON MODEL WHICH NEEDS NO DECOUPLING. Henyey, F.; Zakrzewski, W. J. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 42B: No. 4, 431-4(25 Dec 1972).

A model is presented in which the Pomeron is a related pair of factorizable Regge poles both with intercept one. The model requires a cut (fixed or moving) with a branch point intercept one. In this model the triple Pomeron vertex need not vanish and as a result the Pomeron may couple to asymptotically constant cross sections. The model can even fit pp elastic scattering data moderately well. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 10675, 10698, and 11255.

10652 (CNRS-CPT-72-P-478) ORBITS OF THE ROTATION GROUP ON SPIN STATES. Bacry, H. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Sep 1972. 7p. Dep. NTIS (U. S. Sales Only).

A generalization of the Riemann sphere leads to the knowledge of orbits of SO(3) on spin j-representation space. (France)

10653 (IC-72/79) SOME UNUSUAL APPLICATIONS OF LIE-ALGEBRA REPRESENTATIONS IN QUANTUM THEORY. Barut, A. O. (International Centre for Theoretical Physics, Trieste (Italy)). Aug 1972. 19p. (CONF-720658-1). Dep. NTIS (U. S. Sales Only).

From SIAM-Drexel conference on Lie algebras; Philadelphia, PA. (15 Jun 1972).

The treatment covers Lie algebra representations for self-adjoint extension of certain operators, Lie algebra description of continuous spectra of quantum theory, complete dynamical Lie algebra and infinite-component wave equations, induced representations of the Poincare group from infinite-dimensional representations of dynamical groups, solution of scattering problems by dynamical algebras, applications of indecomposable representations of Lie algebras, and infinite-parameter Lie algebras. (J.F.P.)

10654 (JINR-P2-6740) GENERAL VERTEX FUNCTION IN THE MODEL WITH THE FINITE SET OF OSCILLATORS. Popov, Kh. D.; Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Using the representation of the group SL (2,R) in the space of the coherent states of 5-dimensional oscillators one obtains an operator, which corresponds to the general vertex function. With the aid of this operator the diagram with semimultiperipherical configuration of the external particles is also constructed. (auth)

10655 (NP-19611) ON THE TRANSFORMATION FUNCTIONS FROM THE jm BASIS TO THE z BASIS FOR THE UNITARY REPRESENTATIONS OF SL(2,C). Note No. 386. Paciello, M. L.; Sciarrino, A.; Taglienti, B. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 28 Jun 1972. 15p. Dep. NTIS (U. S. Sales Only).

The covariance properties of the transformation functions from the jm basis to the z basis are written down and solved explicitly for irreducible unitary representations of SL(2,C) belonging to the principal series. The explicit expression of these functions in terms of elementary functions is given. Some interesting completeness and orthogonality properties for the expansion of one and two complex variable functions are pointed out. (auth)

10656 LOGARITHMIC SCALING AND SPONTANEOUS BREAKING. Ferrara, S. (CNEN, Frascati, Italy); Grillo, A. F.; Gatto, R. Phys. Lett.; 42B: No. 2, 264-6(27 Nov 1972).

Indecomposable representations of dilatations allow for logarithms in scale invariant operator product expansion. It is proved that in absence of spontaneous breaking, they are incompatible with conformal invariance and positivity. (auth)

10657 GENERALIZED 3j- AND 6j-COEFFICIENTS AND THEIR SYMMETRIES. D'Adda, A. (Istituto Nazionale Fisica Nucleare, Turin); D'Auria, R.; Ponzano, G. Lett. Nuovo Cim.; 5: No. 15, 973-7(9 Dec 1972).

It is found that there exists a highly symmetrical structure which contains certain extensions, provided one considers—among the SU(1,1) unitary representations—only the discrete ones. In this way the relations between SU(2) and SU(1,1) coupling and recoupling coefficients appear as particular instances of the symmetries of the structure. A preliminary account of the main results is given omitting all proofs. (J.F.P.)

10658 REMARKABLE CONNECTION BETWEEN THE MULTI-VENEZIANO INTEGRAND AND THE CHARACTER OF SPECIAL UNITARY GROUPS. Santhanam, T. S. (Univ., Bonn). J. Math. Phys. (N. Y.); 13: No. 11, 1823-5(Nov 1972).

The remarkable connection that exists between the multi-Veneziano integrand at a fixed point of the external momenta and the character of special unitary groups is exhibited explicitly. Some remarks are made on such a connection for arbitrary external momenta. (auth)

10659 INTEGRABILITY OF REPRESENTATIONS OF FINITE DIMENSIONAL REAL LIE ALGEBRAS. Simon, Jacques (Univ., Dijon, France). Commun. Math. Phys.; 28: No. 1, 39-46(1972).

An integrability criterion is given for Lie algebra representations in a reflexive Banach space. Applications are given to skewsymmetric Lie algebra representations in Hilbert spaces and to essential skewadjointness of a sum of two skewadjoint operators. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 10557, 10564, 10594, and 10850.

10660 PRECISE TEST OF SU(2) CHIRAL BREAKING. A COLEMAN-GLASHOW FORMULA FOR PSEUDOSCALAR MESONS. Cicogna, G. (Univ., Pisa, Italy); Strocchi, F.; Vergara-Caffarelli, R. Phys. Rev. Lett.; 29: No. 25, 1702-4(18 Dec 1972).

As a precise and model-independent test of SU(2) chiral breaking ($\epsilon_3 u_3$), the analog of the Coleman-Glashow formula for pseudoscalar mesons is derived, and it is found to be satisfied within 1%. The presence of the term $\epsilon_3 u_3$ in the Hamiltonian density is therefore strongly supported by the experimental data. (auth)

10661 LEPTON SYMMETRY. Meshkov, S. (National Bureau of Standards, Washington, DC); Rosen, S. P. Phys. Rev. Lett.; 29: No. 26, 1764-7(25 Dec 1972).

Assuming a weak interaction invariant under $SU(2)_M \otimes SU(2)_I$, it is shown that M-spin conservation leads to the rule $A(\nu_e e^- | \nu_e e^-) - A(\nu_\mu e^- | \nu_\mu e^-) = A(\nu_e \mu^- | \nu_\mu e^-)$ and to other sum rules for leptonic, semileptonic, and trident production processes. The additional assumption of total isospin conservation yields simple relations for lepton-hadron scattering. It is also shown that μ decay is forbidden in lowest order for various symmetry schemes such as the SU(3) and O(3) theories based upon the Konopinski-Mahmoud assignment of lepton number. (auth)

10662 SYMMETRY BREAKING AND K DECAYS. Bace, M. Rochester, NY; Univ. of Rochester (1972). 102p. University Microfilms Order No. 72-28,722.

Thesis.

A general condition is derived which allows a local field (in an arbitrary field theory) to belong simultaneously to a fixed representation of the Lorentz group and a given representation of a broken symmetry group. Specializing to local currents one obtains the condition of Gross and Jackiw for a complete current algebra, the condition of Bég et al., for the dimension of a current component to be independent of its Lorentz index, and the condition necessary for covariant derivatives in broken chiral theories to be covariant. Also, one is able to understand observations of Kimel on the failure of complete current algebra in gauge field models with mass-breaking terms, those by Takahashi and others on the impossibility of assigning a dimension to Duffin-Kemmer scalar and Klein-Gordon vector fields, and some other specific results. The above condition allows a critical examination of operator product expansions. The point of this work is in its generality; it makes possible a unified view of a large number

of specific results and observations. A variety of decays of the K-meson is treated. Using a weak Lagrangian model satisfying exactly $\Delta I = \frac{1}{2}$ rule, and assuming the existence of an iso-spin breaking Hamiltonian $H_3 = \epsilon_3 u_3$ which belongs to the same representation of $SU_3 \otimes SU_3$ as do the symmetry breaking terms of the Gell-Mann, Oakes and Renner model (i.e., $u_3\epsilon(3,\bar{3}) \oplus (\bar{3},3)$) the reduced decay rate ratios of $K \to 3\pi$ and $K \to 2\pi$ decays are calculated. These ratios are observed to vary from the $\Delta I = \frac{1}{2}$ rule predictions by about 10%, and can be explained if $\epsilon_3/\epsilon_0 \sim 0.05$. Next, simple pole models are considered in the $K_L \to 2\gamma$, $K_L \to \pi^0 + 2\gamma$, and $K^+ \to \pi^+ + 2\gamma$ radiative decays. Perhaps surprisingly the predicted decay rate for $K_L \to 2\gamma$ is too large by two orders of magnitude. Next, it is pointed out that the yet unmeasured four-body decay modes $K_{L,S} \to \pi^+\pi^0 e\nu$ can be used to distinguish between the sets of experimentally observed p-wave $\pi^+\pi^-$ scattering parameters of $K^+ \to \pi^+\pi^- e^+\nu$ decays. Also, the possibility of measuring CP violation in $K_L \to e^+e^-e^+e^-$ decay is discussed. (Diss. Abstr. Int., B)

Applications (Strong)

Refer also to abstract 11066.

10663 (NP-19612) PROJECTIVE INVARIANCE OF DUAL RESONANCE MODELS FROM SPIN ANALYTICITY AND LORENTZ INVARIANCE. Note No. 388. Paciello, M. L.; Sciarrino, A.; Taglienti, B. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 30 Jun 1972. 21p. Dep. NTIS (U. S. Sales Only).

The problem of the origin of the projective invariance of the dual resonance models is investigated. An explanation in terms of the Lorentz group is suggested via the definition of generalized spinor amplitudes in which the external "particles" are assigned to unitary, irreducible representations of SL(2,C). A generalization of the Virasoro amplitude for external spinning particles is obtained. (auth)

10664 HADRONIC REGGE SEQUENCES AS PRIMITIVE REALIZATIONS OF SL(3,R) SYMMETRY. Biedenharn, L. C.; Cusson, R. Y.; Han, M. Y.; Weaver, O. L. (Duke Univ., Durham, NC). Phys. Lett.; 42B: No. 2, 257-60(27 Nov 1972).

Four primitive infinite dimensional unitary representations of the group of rotations and deformations—SL(3, R)—are constructed and associated with the four Regge trajectories: π, ρ, N, Δ. The model predicts E2 transition moments and a power law for E versus j consistent with the Chew–Frautschi relation $E \sim j^{\frac{1}{2}}$. (auth)

10665 O(4) TREATMENT OF THE ELECTROMAGNETIC-WEAK SYNTHESIS. Pais, A. (Rockefeller Univ., New York). Phys. Rev. Lett.; 29: No. 25, 1712-15(18 Dec 1972).

A gauge theory is outlined in which the existence of the Cabibbo angle θ, leptonic CP-invariance violation, and μ-e nonuniversality are linked. To O(G), the sole source of nonleptonic decays is a neutral current. There is no conflict with present neutrino data. This CP-invariance violation induces only superweak effects in K decays. A strategy for finding θ is indicated. (auth)

10666 REPRESENTATION OF SU_3 X SU_3 CHIRAL ALGEBRA FOR BARYONS. Buccella, F. (Univ., Rome); Nicolo, F.; Pugliese, A. Nuovo Cim.; 12A: No. 3, 640-50(1 Dec 1972).

A mixing operator U(Z') is presented for baryons, which transforms the SU_6 axial charges in a more realistic set satisfying at the same time the equations $[Q_5^\alpha, Q_5^\beta] = if^{\alpha\beta\gamma}Q^\gamma$, $[Q_5^\alpha(Q_5^\alpha, m^2)] = 0$. The (56 ⊕ 70, any L) $SU_6 \otimes O_3$ representations are considered to obtain a consistent result. The octet chiral wave function comes out in good agreement with experimental data and the coupling constants between the (56, L = 0) and any other representation with arbitrary L correspond exactly in a dual sense to the exchange in the t-channel of a tensor nonet and a vector octet with the couplings proposed by Cabibbo, Horwitz and Ne'eman. The explicit form of the m^2-operator is given. (auth)

Field Theories

General

Refer also to abstracts 10299, 10543, and 10583.

10667 (LA-tr-72-26) SOLVING LAPLACE'S EQUATION WITH AXIAL SYMMETRY BY THE DIFFERENCE METHOD. Davidenko, D. F. Translated by Anna Vakar (Los Alamos Scientific Lab., N. Mex.), from Dokl. Akad. Nauk SSSR; 114: 690-3 (1957). 8p. Dep. NTIS.

Harmonic functions are used to construct five- and nine-point difference equations for solving an axially symmetric Dirichlet problem for the Laplace equation. These difference equations are somewhat more accurate and convenient for theoretical investigations than those previously derived. As an example the electric field within a cylindrical box with circular cross section is considered. (J.F.P.)

10668 TREDER'S INTERPRETATION OF EINSTEIN'S UNIFIED FIELD THEORY. Buchner, K. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1421-2(Oct 1972).

A proposal was previously made by Treder to interpret Einstein's unified theory as equations for spin-$\frac{1}{2}$ particles. It is suggested that some difficulties can be resolved if the Weyl-spinor is interpreted as some new kind of spinor potential in a way that is similar to Heisenberg's nonlinear spinor theory. (L.B.S.)

10669 REPRESENTATIONS OF THE GAUGE GROUPS OF ELECTRODYNAMICS AND GENERAL RELATIVITY. Girardello, L.; Wyss, W. (Univ. of Colorado, Boulder). Helv. Phys. Acta; 45: No. 2, 197-202(1972).

A semidirect product of the gauge groups of electrodynamics and general relativity is determined and unitarily represented on a Hilbert space of the type $\mathfrak{L}_2(\mathcal{F},\mu)$. (auth)

10670 DEPENDENCE OF THE VACUUM ENERGY DENSITY ON BARE MASS IN SCALAR THEORIES. Vasil'ev, A. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 13: No. 2, 178-83(Nov 1972). (In Russian).

In the scalar case the transition to the Euclidean field theory simplifies to a great extent the analysis of the dependence of the vacuum energy density on bare masses and coupling constants. (auth

Quantum Field Theory

Refer also to abstracts 10499, 10651, 10662, and 11251.

10671 (CNRS-CPT-72-P-471) REMARKS ABOUT LAGRANGIAN MODELS INVOLVING GAUGE FIELDS. Quaranta, L.; Rouet, A.; Stora, R.; Tirapegui, E. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jul 1972. 16p. Dep. NTIS (U. S. Sales Only).

The definition of the Ward identities (heuristics formulation), the proof of these identities, and their importance in view of defining a positive metric theory in Hilbert space (i.e., constructing a unitary operator, S, and the field variables) are discussed. The class of the models considered involves gauge fields and renormalizable gauge invariance dynamics with spontaneous breaking. (France)

10672 (JINR-P2-6687) APPROXIMATE METHOD OF SOLVING THE EDWARD EQUATION WITH NONRENORMALIZABLE INTERACTION. Gogokhiya, V. Sh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

In the framework of an exactly solved model with nonrenormalizable interaction (Edward's equation), the differential interpolation method was shown and investigated. This enabled one to find the series (modified perturbation theory) of powers of $g^\nu(\ln g)^{n_\nu}$, where n_ν is an integer, and ν is in general noninteger. (auth)

10673 (JINR-P2-6710) RELATIVISTIC ELECTRODYNAMICS. Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Some questions are discussed concerning the four-dimensional formulation of a special theory of relativity. By the example of interaction of a charge and a conductor with the current the value of the product of electrical charge density and the element of a space volume is shown to be dependent on the state of the frame of reference motion. It is shown also that the energy and momentum of the electron electromagnetic field form a four-vector. (auth)

10674 (JINR-P2-6756) LOCAL PROPERTIES OF NONLOCAL GENERALIZED FUNCTIONS. Efimov, G. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 32p. (In Russian). Dep. NTIS (U. S. Sales Only).

The role of a space of test functions when formulating the principle of locality and causality in quantum field theory is discussed. In cases when the space of test functions consists of entire analytical functions the concept of projection sequences of functions is introduced to investigate the space-time properties of different objects in quantum field theory (commutators of field operators or currents, causality of the S-matrix and

so on). These projection sequences pick out the projection of the support of an analytical functional in the complex space C^4 on the real space R^4. A class of relativistic invariant distributions is considered with the help of these projection sequences. (auth)

10675 (LNF–72/54) CONFORMAL SYMMETRY, OPERATOR PRODUCTS AND CANONICAL SCALING. Ferrara, S. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 13 Jun 1972. 14p. (CONF-720564–1). Dep. NTIS (U. S. Sales Only).

From Meeting on high energy scattering elementary particles; Black Forest, West Germany (25 May 1972).

Some recent results on exact and broken conformal invariance in field theory are summarized. The implications of conformal symmetry on operator product expansions is discussed. Also covered are conformal invariance on the light cone for deep inelastic scattering and asymptotic form factors, full conformal symmetry for selection rules and operator product expansions, and canonical scaling and free limiting theory. (J.F.P.)

10676 COVARIANT PERTURBATION THEORY AND CHIRAL SUPERPROPAGATORS. Ecker, G.; Honerkamp, J. (CERN, Geneva). Phys. Lett.; 42B: No. 2, 253-6(27 Nov 1972).

A covariant formulation of perturbation theory is used for the non-linear chiral invariant pion model to define chiral superpropagators leading to S matrix elements which are independent of the choice of the pion field coordinates. The relation to the standard definition of chiral superpropagators is discussed. (auth)

10677 GENERALIZATIONS OF THE GOLDSTONE AND THE COLEMAN THEOREMS. Dothan, Y.; Gal-Ezer, E. (Tel-Aviv Univ., Israel). Nuovo Cim.; 12A: No. 2, 465-79(21 Nov 1972).

Generalizations of the Goldstone theorem and of the Coleman theorems are formulated and proven within the framework of the Wightman field theory. The generalization of the Goldstone theorem is to a class of currents in which implicit and explicit co-ordinate dependence are mixed. It is found that vacuum non-invariance entails the existence of certain masses in the energy-momentum spectrum which are not necessarily zero. The generalizations of the Coleman theorems are to local tensor fields and to several classes of fields in which implicit and explicit co-ordinate dependence are mixed. Several examples are examined in light of the new theorems. (auth)

10678 QUANTIZATION OF FREE FIELDS DEFINED ON A SPACE–TIME LATTICE. Meessen, A. (Univ. Catholique, Louvain, Belgium). Nuovo Cim.; 12A: No. 2, 491-508(21 Nov 1972).

The ultimate limit for the smallest measurable distance should be considered as an unknown quantity, whose value a could be finite as well as zero. This implies that the usual concept of a space-time continuum has to be replaced by the concept of a space-time lattice, and that all field amplitudes can only be defined on the corresponding lattice points. It is shown that a natural extension of the usual theory of field quantization leads then to the generalized "energy addition law" $\sin(Ea/2\hbar c) = \Sigma_n \sin(E_n a/2\hbar c)$, where E represents the total energy of an ensemble of freely moving particles, while the energies of the individual particles are represented by E_n. This law reduces to the usual one only when a = 0 or when the energies are much smaller than $\hbar c/a$. But it corresponds exactly to the energy addition law which is needed in order to preserve the relativistic invariance of the theory. Besides the previously considered generalizations of the Schroedinger, Gordon–Klein and Dirac equations, it is also possible to set up a corresponding generalization of Maxwell's equations. Finally it is shown that the (pseudo-) Hamiltonian density of a field can only be subject to an equation of continuity when the fields are varying sufficiently slowly. (auth)

10679 DECOUPLING OF THE POMERANCHUK POLE FROM ALL INELASTIC PROCESSES. Rajaraman, R. (Univ. of Delhi). Phys. Lett.; 42B: No. 2, 271-5(27 Nov 1972).

It is shown that if $\alpha_P(0) = 1$, then a factorisable Pomeranchuk pole must decouple from all inelastic vertices, when the Pomeron mass is zero. (auth)

10680 CONSISTENCY BETWEEN LAGRANGIAN AND HAMILTONIAN FORMALISMS IN QUANTUM MECHANICS. III. Kimura, T.; Ohtani, T.; Sugano, R. (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1395-1407(Oct 1972).

A consistent quantization procedure is proposed for the non-linear Lagrangian $L = (1/8) \times g^{-\frac{1}{4}}\{g_{ik}, \dot{q}^k\}g^{\frac{1}{4}}g^{ij}\{g_{jm}, \dot{q}^m\}g^{-\frac{1}{4}} - v(q)$. The previous formalism is extended which was formulated by means of a q-number variation principle for cases with special g_{ij}, so that it is applicable to the general case with arbitrary g_{ij}. The commutation relations of q-number variations δq^i and $\delta\dot{q}^j$ with q^i and $\dot{q}^j$ are taken as unknown functions in deriving the Euler–Lagrange equation. However, in the final expression of the Euler–Lagrange equation and the Hamiltonian, these unknown functions can be eliminated so that the equation of motion and the Hamiltonian are uniquely given by g_{ij} and their derivatives. In general the unknown functions are not well defined in the overall region of q^i, contrary to the special cases given in previous papers. For illustration, a simple example of two-dimensional space is presented. The Hamiltonian as the time generator of the system is given by $H = L + 2v - (\hbar^2/4)R$ where R is the curvature scalar constructed from g_{ij}. With this H the canonical equation of motion is in accord with the Euler–Lagrange equation. (auth)

10681 AMBIGUITY IN PARTICLE INTERPRETATION OF GAUGE FIELD OF THE YANG–MILLS TYPE. Okabayashi, T. (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1375-94(Oct 1972).

The breakdown of the invariance of a system described by a gauge field under the non-Abelian local gauge transformation group is studied in the radiation gauge systematically, first in classical theory and then in the Heisenberg picture. In quantizing the gauge field the commutation relations among field operators, the constraint and the wave equation are derived through the characteristics of displacement operators in Minkowski space. The requirement that the gauge field corresponds to a particle with unit spin is translated first in classical theory into two conditions on gauge functions. In quantum theory these conditions are replaced by more restrictive ones, and one also has to introduce another condition; the commutation relation of the gauge function with the conjugate momentum to the gauge field. Then the wave equation is covariant, and the covariance of the constraint can be proved without referring to the last condition. But the commutation relations among field operators are not invariant. Finally the particle-like aspects are studied by considering the interaction picture. Due to the breakdown of the symmetry there is an ambiguity specific to non-Abelian gauge fields in connecting operators in the Heisenberg picture and those in the interaction picture. It is shown that this ambiguity can be utilized, when quantizing the apparently massless classical gauge field, to obtain a massive gauge particle. (auth)

10682 ELECTROMAGNETIC PROPERTIES OF A NEW SPIN ½ FIELD. Capri, A. Z. (Univ. of Alberta, Edmonton). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1364-74(Oct 1972).

The recently published 16-component theory for a spin ½ field is examined. It is shown that this theory is equivalent to the Dirac theory in the absence of interaction. If the field is minimally coupled to an electromagnetic field it can again be reduced to a Dirac-like field with an additional Pauli term. This shows that this field provides a stable representation of the Poincaré group. The possibility that this field may describe physical particles is also examined. (auth)

10683 NEUTRINO THEORY OF LIGHT. Inoue, H.; Tajima, T.; Tanaka, S. (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1338-63(Oct 1972).

The neutrino theory of light is reexamined. The electromagnetic potential $A_\mu(x)$ describing both the transverse and longitudinal waves is expressed in a bilinear form of the neutrino field $\psi_\nu(x)$, according to the gauge independent formalism of quantum electrodynamics. The continuous mass spectrum $\rho(\kappa^2)$ is introduced for the composite photon, which plays an essential role in overcoming present serious problems. It is concluded that the conceivable differences in the statistical behavior of composite photons and in the scattering matrix from the results of conventional quantum electrodynamics, remains of order ϵ (ϵ is the upper bound of the continuous mass spectrum $\rho(\kappa^2)$) assuming ϵ is sufficiently small compared with the energy-momentum resolution of particles under interactions with photons, including photons themselves. (auth)

10684 FIELD THEORY OF DUAL-RESONANCE MODEL. Nakawaki, Y.; Saito, T. (Osaka Univ., Toyonaka, Japan). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1324-37(Oct 1972).

By the second-quantization of the string model of hadrons, a field theory of dual resonance model is obtained. The subsidiary conditions are imposed in analogy to the Lorentz condition in quantum electrodynamics. A compatibility of the quantization rule with the subsidiary condition is quite satisfactory. As a result a simple Feynman rule is found, which leads to the dual amplitudes. The iso-spin can be quite easily built in our model. (auth)

10685 APPROXIMATE SYMMETRIES AND PSEUDO-GOLDSTONE BOSONS. Weinberg, S. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 29: No. 25, 1698-1701(18 Dec 1972).

In theories with spontaneously broken local symmetries, renormalizability sometimes forces the scalar field interactions to have a larger group of symmetries than the gauge field interactions. Symmetries can then arise in zeroth order which are violated by finite higher-order effects, thus providing a possible natural explanation of the approximate symmetries observed in nature. Such theories contain spinless bosons which behave like Goldstone bosons, but which pick up a small mass from higher-order effects. (auth)

10686 WHY DOES THE POMERANCHUK SINGULARITY HAVE A UNIT INTERCEPT. Harari, Haim (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 29: No. 25, 1708-12(18 Dec 1972).

It is suggested, contrary to the spirit of the Amati–Fubini–Stanghellini multiperipheral model and a φ^3 ladder theory, that the relation $\alpha_P(0) = 1$ is independent of the strength of the strong interaction. It is proposed that the "zero strength" ($g \to 0$) limit of a future correct strong-interaction theory will collapse into a vector-type field theory, guaranteeing $\alpha_P(0) = 1$ even as $g \to 0$. The intercept of the leading non-Pomeranchukon exchange then becomes lower when g increases. Specific models which are consistent with this approach lead to a new relation between this intercept and the moments of the multiplicity distribution. (auth)

10687 DILATATION INVARIANCE AND THE WILSON EXPANSION. Dell'Antonio, G. F. (Univ., Naples). Nuovo Cim.; 12A: No. 3, 756-62(1 Dec 1972).

A few simple remarks on dilatation invariance in field theory and its relevance in connection with the short-distance behavior of products of fields are given. (auth)

10688 ANALYTICITY IN QUANTUM FIELD THEORY. I. THE TRIANGLE GRAPH REVISITED. Rechenberg, H.; Sudarshan, E. C. G. (Univ. of Texas, Austin). Nuovo Cim.; 12A: No. 3, 541-68(1 Dec 1972).

The leading singularity is studied in scalar triangle graphs. It is observed that in some examples of practical interest like the "form factors" the anomalous singularity does not arise when one performs the momentum integrations in the Feynman–Stückelberg amplitudes, indicating that quantum field theory will not necessarily yield the so-called analytic scattering amplitudes. However, the analytic triangle form factor which shows the anomalous singularity and the corresponding Feynman–Stückelberg amplitude coincide everywhere above the normal thresholds, especially in the "physical region" of the variables. But one should be warned against the uncritical use of conventional methods and concepts, even in simple perturbation structures. (auth)

10689 GAUGE INVARIANT DECOMPOSITION OF YANG–MILLS POTENTIALS. Treat, R. P. (West Virginia Univ., Morgantown). J. Math. Phys. (N. Y.); 13: No. 11, 1704-14 (Nov 1972).

The Yang–Mills (YM) potentials are decomposed into an isovector part and a part which transforms nonhomogeneously under local gauge transformations. Two decompositions are shown; one of them is based on a gauge-invariant version of the transversality condition, and the other arises from a gauge-invariant modification of the Lorentz condition. The latter is Lorentz as well as gauge invariant. The gauge invariance of the decompositions is obtained at the expense of locality since the separate parts of the decomposed potential are functionals of the full YM potential. The transverse-longitudinal decomposition is used to throw the YM sourceless field equations into a gauge-invariant Hamiltonian form. Static fields in the Hamiltonian formulation are discussed. The decompositions are used to construct massive, gauge-invariant but nonlocal Lagrangians. A Lorentz and gauge-invariant nonlocal interaction of the YM field with a spinor–isospinor field is formed. The transverse-longitudinal decomposition is used to investigate the geometric structure of a configuration space Ω of YM potentials. The nonexistence of submanifolds of Ω orthogonal to the gauge-invariant manifolds $X \in \Omega$ is proved in contradistinction to the electromagnetic case. A Green's functional for the Yang–Mills field is represented explicitly by an infinite power series of functionals and is shown to be self-adjoint. (auth)

10690 CURRENTS, STRESS TENSOR, AND GENERALIZED UNITARITY IN CONFORMAL INVARIANT QUANTUM FIELD THEORY. Mack, G. (Univ., Bern); Symanzik, K. Commun. Math. Phys.; 27: No. 4, 247-81(1972).

Matrix elements of internal symmetry currents and energy momentum density tensor are constructed in Migdal Polyakov conformal invariant bootstrap field theory. Their 3-point functions satisfy Bethe Salpeter equations which determine any free coefficients that may still occur in the conformal invariant Ansatz. Ward identities are verified for all n-point functions. They imply correct equal time current commutation relations. A proof of generalized unitarity is also given. Various equivalent forms of the propagator bootstrap are discussed. The algebraic techniques also yield an eigenvalue equation for first-order correction to the exactly conformal invariant theory, assuming the latter is Gell–Mann Low large momentum asymptote of a renormalizable finite mass theory. (auth)

10691 DUAL SYMMETRY OF QUANTUM ELECTRODYNAMICS. Strazhev, V. I. (Inst. of Physics, Minsk). Teor. Mat. Fiz.; 13: No. 2, 200-8(Nov 1972). (In Russian).

It is shown that the dual symmetric formulation of quantum electrodynamics can be achieved without introducing the new type of particle (the Dirac monopole). On this basis the quantum theory of magnetic charge is analyzed. The new argumentation in favor of the necessity of the charge quantization condition is given. (auth)

10692 INVARIANT REGULARIZATION OF GAUGE THEORIES. Slavnov, A. A. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 13: No. 2, 174-7(Nov 1972). (In Russian).

A general method of invariant regularization of gauge theories is developed. The renormalizability of the theory of the massless Yang–Mills field and the self-consistence of the Ward identities obtained earlier are proved. (auth)

10693 SCATTERING THEORY IN A MODEL OF QUANTUM FIELDS. II. Albeverio, Sergio (Princeton Univ., NJ). Helv. Phys. Acta; 45: No. 2, 303-21(1972).

The study of the scattering theory is pursued in Nelson's model with relativistic kinetics ("Eckmann's model"). For the choice of mass renormalization yielding a renormalized Hamiltonian with the relativistic single-particle spectrum, one constructs physical asymptotic nucleon fields as strong limits of dressed fields on dense sets of states with finitely many nucleons and arbitrarily many mesons. The commutation relations of the asymptotic fields among themselves, with the asymptotic meson fields and with the Hamiltonian are derived as well as the asymptotic decomposition of the latter and the relation with the wave operators. An expression for the S-matrix is also given, which is then discussed for the case of the meson-nucleon scattering. (auth)

10694 DIFFERENTIAL EQUATION APPROACH TO QUANTUM FIELD THEORY: SCATTERING FOR THIRRING'S MODEL. De Mottoni, Piero (CNR, Rome). Ann. Inst. Henri Poincare, Sect. A.; 16: No. 4, 265-77(1972).

Scattering problems are considered in the framework of the Thirring model. The latter is described by a nonlinear equation in a Banach space. Some general properties of nonlinear scattering in Banach spaces are derived and applied to the case under consideration. Wave and scattering operators become trivial as in the formal approach to this model. (France)

10695 CLASSICAL ORIGIN OF DIRAC-LIKE WAVE EQUATIONS. Rafanelli, Kenneth (Queens Coll., New York). Can. J. Phys.; 50: No. 20, 2489-95(15 Oct 1972).

The group structure of the intrinsic dynamical variables describing the relativistic motions of the classical pure gyroscope is investigated. It is shown that the 10 elements of this group, the 6 components of the spin angular momentum tensor, and the four-velocity components have Poisson bracket relations among themselves characteristic of Lie algebra of the De Sitter group. This algebraic result allows a complete description of the free particle motions to be deduced from a proper-time Hamiltonian linear in the four-momentum components. Thus we are led, via the correspondence principle, to a classical understanding of the origin of the algebraic and dynamical properties characteristic of Dirac-like relativistic wave equations. (auth)

10696 RELATIVITY AND QUANTUM MECHANICS. Dirac, P. A. M. (Florida State Univ., Tallahassee). Fields Quanta; 3: No. 2, 139-64(Oct 1972).

A discussion is given on the development and the main features of relativity and quantum mechanics. The difficulties encountered in reconciling the conflicts between the two theories are discussed. (L.B.S.)

10697 RECENT DEVELOPMENTS IN BETHE–SALPETER EQUATION. Green, H. S. (Adelaide Univ.); Biswas, S. N. Fields Quanta; 3: No. 2, 241-61(Oct 1972).

A review is given of the solutions of the Bethe-Salpeter equation in the light of recent developments. A form of the Wick equation is used to obtain an exact solution for both scattering and bound states, which is used to illustrate the general properties of the Bethe-Salpeter amplitude. The use of Wick's equation to study the scale invariance of the electroproduction structure functions for inelastic electron scattering by protons is also discussed. (L.B.S.)

10698 SCALAR QUANTUM FIELD THEORY IN A CLOSED UNIVERSE OF CONSTANT CURVATURE. Fulling, S. A.

Princeton, NJ; Princeton Univ. (1972). 532p. University Microfilms Order No. 72-29,783.

Thesis.

Quantization of a massive neutral scalar field without self-interaction defined on a space-time manifold with given metric is studied, with emphasis on the two-dimensional de Sitter space. Applications in both general relativity and constructive quantum field theory are envisaged. The canonical formalism is developed for an arbitrary metric, and for special classes of metrics a Fock space can be constructed in analogy to the case of flat space. However, in this way one is led to different theories for the same manifold, with different definitions of particle observables and energy density. In particular, two nonstandard quantizations of the free field in flat space are exhibited, and three approaches to the two-dimensional de Sitter space are compared: a covariant theory in which the states of a particle transform according to a representation of the symmetry group of the space, a quantization exploiting the static nature of a portion of the universe bounded by horizons, and an "expanding universe" theory in which the particle observables diagonalize the field Hamiltonian at each time and the particle number is not constant. The representations of the canonical commutation relations in the first and third cases are unitarily equivalent. It is concluded that in this context choice of a unique physical representation of the fields is impossible. One must deal with an abstract algebra of observables associated with the field. Nevertheless, some representations are more likely to be useful than others. In this spirit a proposal is made for a definition of particle observables based on diagonalization of the Hamiltonian on geodesic hypersurfaces. In Minkowski space this condition distinguishes the standard theory from the others. In two-dimensional de Sitter space such a theory predicts finite and reasonably small creation of particles. The relation of "contraction" between the irreducible unitary representations of the de Sitter group and those of the Poincare group of the same dimension is discussed in some detail. It is indicated that some arbitrariness can be removed from the treatment by considering concrete realizations of the representations by functions on the respective homogeneous spaces. The analogous case of the three-dimensional rotation group and the Euclidean group of the plane is treated. (Diss. Abstr. Int., B)

10699 QUANTUM FIELD THEORY OF SPINLESS AND SPIN-HALF TACHYONS. Bandukwala, J. S. Norman, OK; Univ. of Oklahoma (1972). 56p. University Microfilms Order No. 72-29,874.

Thesis.

The classical difficulties presented by tachyon existence were examined. The problem of imaginary energy was successfully overcome. But the causality objection still persists. Classically tachyons raise a very perplexing problem. In the transcendental frame, the observer notes that the tachyon exists for just one moment of time, although it has a finite nonzero momentum. This implies that at one time the observer finds the tachyon as having a finite nonzero momentum; at all other times he does not observe the tachyon at all. Does this violate the conservation of momentum? A quantum field theory of scalar tachyons is developed. The commutator function is found to vanish at all space-like points. This does not imply that tachyons convey messages with a speed less than the speed of light. Rather it means that a tachyon going from the space time point x to the space time point y is equivalent to one going from y to x. A tachyon spinor theory developed shows some very interesting features. Energy momentum is not an observable of a tachyon spinor field; as the Hamiltonian of the field is no longer hermitean. Helicity takes on an added significance, as it is the only physical quality that is conserved for both tardyon and for tachyon spinor fields. The brief scattering problem discussion implies that tachyon exchanges are long range in nature. The place to look for tachyon exchange would more likely be in gravitational or in Coulomb interaction experiments, rather than in strong and weak interaction experiments. This is further reinforced by the fact that for large distances as well as in the limit of zero tachyon mass interaction, the tachyon potential reduces to the Coulomb potential. If tachyon exchanges are to be found in nature, it would have vast effects in physics; for this would as such return one to the old Newtonian concept of action at a distance. (Diss. Abstr. Int., B)

10700 MOST GENERAL STRESS TENSOR OF A SPIN-½ PARTICLE. Hayashi, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Lett. Nuovo Cim.; 5: No. 13, 883-7(25 Nov 1972).

It was previously found that if the energy-momentum tensor is defined by a source of gravitation, then the ambiguity inherent in the kinematical definition will be shifted to many possibilities in choosing the gravitational interactions of a spin-½ particle. All the possible gravitational interactions of a spin-½ particle were enumerated, provided that interaction Lagrangians should not involve higher derivatives than those appearing in the free Dirac and free gravitational Lagrangians. This result is used in calculating the most general stress tensor for a spin-½ particle. (L.B.S.)

10701 HAMILTONIAN SPECTRA AND ALGEBRAIC EQUIVALENCE OF QUASI-FREE STATES OF THE FERMION FIELD. Ghez, P. Ann. Inst. Henri Poincare, Sect. A; 16: No. 4, 235-46(1972). (In French).

Connections between the asymptotic ratio set introduced by Araki and Woods for the classification of the factors and spectrum of the Tomita modular operator of some representations of canonical anticommutation relations are studied. (France)

10702 SPINORIAL FIELDS IN GENERAL RELATIVITY: THE PARTICULAR CASE OF A DE SITTER SPACE-TIME AND THE WAVE EQUATIONS FOR HIGH SPINS. Castagnino, Mario. Ann. Inst. Henri Poincare, Sect. A.; 16: No. 4, 293-41(1972). (In French).

It is demonstrated that the tensorial theory and the Farita-Schwinger theory are the correct theories in the curved space-time since its wave function in the De Sitter space-time generate irreducible representations of the SO(1,4) group which act as Poincare groups. The necessary conditions ensuring the integrability are established. They are identically zero for spins of 0, ½, and 1 in every case and for spins of ⅜ and 2 in vacuum. (France)

10703 DYNAMICAL FORMULATIONS OF THE CONCEPT OF PARTIAL CONSERVATION OF THE AXIAL-VECTOR CURRENT. Snellman, H. (College de France, Paris). Ann. Inst. Henri Poincare, Sect. A; 16: No. 4, 279-91(1972).

The concept of the partial conservation of the axial-vector current (PCAC) is analyzed in an attempt to extend it to incorporate dynamics. In particular the property of the slow variation (smoothness) of the pion amplitudes defined by PCAC in the external four-momentum squared is studied, and it is found that the simplest mathematically well defined form of smoothness is not possible for a universal dynamical formulation of PCAC. Some a priori new candidates for the interpolating pion field expressed in terms of the basic current operators are also considered, but are found to be equivalent to the PCAC pion field. Finally a modified formulation of PCAC which does not suffer from the problems encountered earlier in the analysis is proposed. (France)

Gravitation and General Relativity

10704 EVALUATION OF THE MASSIVE SUPERPROPAGATOR IN THE f-MESON-GRAVITON MIXING MODEL. Leibbrandt, G.; Williams, R. M.; Capper, D. M. (Imperial Coll. of Science and Tech., London). Nuovo Cim.; 12A: No. 3, 611-39(1 Dec 1972).

Working within the framework of the strong gravity theory using nonpolynomial Lagrangians, the massive superpropagator for a mixed tensor field consisting of Einstein's massless gravity field and the strong gravity field of the massive f-meson was investigated. The final compact expression for the massive superpropagator in Euclidean co-ordinate space has the form of a one-dimensional integral characterized by poles and branch cuts. A similar integral representation was derived for the "pure" f-meson superpropagator. The reality of both integrals is guaranteed by an averaging prescription. Numerical calculations of the massive superpropagator were carried out both in Euclidean x-space and, for the corresponding Fourier transform, in the Symanzik region of the external momenta. (auth)

10705 DYNAMICAL INCONSISTENCY AND CONFORMAL COVARIANCE OF THE MASSLESS TENSOR FIELD. Aragone, C.; Gambini, R.; Siri, R. (Instituto de Fisica, Montevideo). Nuovo Cim.; 12B: No. 2, 219-30(11 Dec 1972).

By means of the recently found Lagrangian for the Nordstrøm theory of scalar gravity one writes down the conformal-invariant field equations of the massless tensor field, as the field equations of the minimal interacting system composed by the spin-2 massless field and the scalar-gravity field. These equations constitute a good example of the well known complexities arising when one is dealing with higher-spin (>1) fields, whether in an external field or interacting with another field. In the present case it is shown that the massless tensor field considered as imbedded in an external scalar field has a different number of degrees of freedom than if it is considered as a part of the whole interacting system. This is achieved by analyzing the evolution of a perturbation on a nontrivial background solution (a pure spin-2 plane wave). It is also shown that secondary constraints do not vanish identically as a consequence of the already studied loss of the Ricci-like identity. (auth)

10706 ANALOG OF THE REISSNER–NORDSTROEM SOLUTION IN THE BRANS–DICKE THEORY. Buchdahl, H. A. (Australian National Univ., Canberra). Nuovo Cim.; 12B: No. 2, 269-87(11 Dec 1972).

Following upon a discussion of Higbie's work on charged-particle solutions in the Brans–Dicke theory, a fairly comprehensive treatment is given of the analog—in this theory—of the Reissner–Nordström solution of general relativity. No restriction is placed upon the value of the parameter $\chi = e^2/\varkappa M^2$ (e = charge, M = active mass, $\varkappa$ = Newton's constant). Ten different classes of solutions have to be contemplated, at least five of which are physically acceptable. All of them are dealt with in turn and the various regions of χ to which acceptable solutions correspond are determined. The investigation concludes with some remarks concerning the vacuum solutions of Brans. (auth)

10707 GAUGE INVARIANCE AND THE QUANTIZATION OF MASS (OF GRAVITATIONAL CHARGE). Motz, L. (Columbia Univ., New York). Nuovo Cim.; 12B: No. 2, 239-55(11 Dec 1972).

Previously it was shown that the Weyl principle of gauge invariance leads to the relation $Gm^2 = \hbar c$ for a particle of inertial mass m obeying the Dirac equation, where G is the Newtonian gravitational constant. Instead of interpreting this equation to mean that G takes on the extremely large value $\hbar c/m^2$ inside a particle like an electron (as was done in I), it is written in the form $Gm^2/c = \hbar$ and treated as a quantization condition on the square of the gravitational charge $\sqrt{G}m$. It is shown that this same quantization condition can be obtained from an angular-momentum component in the general relativistic two-body problem as well as from the Machian definition of inertial mass in a rotating universe by using the Dirac–Schwinger procedure for quantizing charge. From this quantization condition it is deduced that the fundamental particle in nature (the uniton) has an inertial mass equal to about 10^{-5} g. The possibility of using the uniton to shed light on the mystery of the "missing mass" in the universe is discussed. Other cosmological implications of the uniton are also discussed and it is suggested that unitons can clear up the solar-neutrino discrepancy. (auth)

10708 MATTER AND ANTIMATTER FROM GENERAL RELATIVITY. Sachs, M. (State Univ. of New York, Buffalo). Lett. Nuovo Cim.; 5: No. 14, 947-50(2 Dec 1972).

The predictions of the quaternion field representation of general relativity theory for the distinction between the electron and positron (or matter and antimatter generally) are given for the existence of two equally massive spinor particle fields, one interacting attractively and the other repulsively with a given charged matter field. A further prediction follows that associated with the charged-conjugated electrons e^+ and e^- are their charged conjugated members of the doublet μ^+ and μ^-. (J.F.P.)

10709 NULL KILLING VECTORS IN GENERAL RELATIVITY. Debney, G. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Lett. Nuovo Cim.; 5: No. 14, 954-6(2 Dec 1972).

Among the various properties of a null Killing vector K^μ in general relativity theory established are that K^μ is geodesic and shearfree, the complex z of K^μ is purely imaginary, and $K^*_{\mu;\nu}K^{\mu\nu} = 0$. Also Petrov types possible with a null Killing vector are discussed. (J.F.P.)

10710 GRAVITATIONAL VERTEX IN EIKONAL APPROXIMATION. Aydin, Z. Z.; Barut, A. O. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 14, 963-6(2 Dec 1972).

The rainbow graph is evaluated in the eikonal approximation. Also bound-state poles are determined in the timelike region below threshold. This would be useful in estimating the gravitational shift of the H atom levels, and it is the first explicit sum of infinitely many gravitons in any approximation. The case of two-body scattering with multigraviton exchanges is discussed. (J.F.P.)

10711 $SL_{6,C}$ GAUGE INVARIANCE OF EINSTEIN-LIKE LAGRANGIANS. Isham, C. J. (Imperial Coll. of Science and Tech., London); Salam, A.; Strathdee, J. Lett. Nuovo Cim.; 5: No. 15, 969-72(9 Dec 1972).

The Einstein gravitational Lagrangian is rewritten in a Dirac γ matrix basis emphasizing its $SL_{2,C}$ gauge invariance aspects. The purpose is to show that the underlying $SL_{2,C}$ gauge symmetry can be immediately generalized to $SL_{6,C}$ or $U_{6,6}$ without increasing the dimensionality of space and time. (J.F.P.)

10712 ALL STATIONARY VACUUM METRICS WITH SHEARING GEODESIC EIGENRAYS. Kota, J.; Perjes, Z. (Central Research Inst. for Physics, Budapest). J. Math. Phys. (N. Y.); 13: No. 11, 1695-9(Nov 1972).

The general solution of the field equations of stationary vacuum gravitational fields possessing geodesic eigenrays with nonvanishing shear is obtained. Nontrivial solutions exist only if the eigenrays do not rotate. The resulting metrics fall into two classes: either there is a functional dependence among the field quantities (this class belongs to the Papapetrou solutions), or the quantity γ^0, which in the shear-free case has been interpreted as the central mass, is uniquely determined. This latter class consists of two space-times. The curvature invariants vanish in the $r \to \infty$ limit for both solutions; however, the metrics exhibit singular behavior in this limit. (auth)

10713 SCALAR–TENSOR THEORY OF GRAVITATION IN A LYRA MANIFOLD. Halford, W. D. (Massey Univ., Palmerston North, New Zealand). J. Math. Phys. (N. Y.); 13: No. 11, 1699-1703(Nov 1972).

A closed-form exact solution to the field equations of a scalar–tensor theory, formally similar to the Brans–Dicke theory, is obtained. It is shown that the present theory predicts the same effects, within observational limits, as the Einstein theory. (auth)

10714 DISPERSION OF GRAVITATIONAL WAVES. Madore, J. (Institut Henri Poincare, Paris). Commun. Math. Phys.; 27: No. 4, 291-302(1972).

A definition is given of a plane gravitational wave in a curved background space-time manifold. For a particular background metric, a dispersion relation for the waves is derived analogous to that satisfied by plane electromagnetic waves in a dilute plasma. (auth)

10715 QUADRATIC FIRST INTEGRAL FOR THE CHARGED PARTICLE ORBITS IN THE CHARGED KERR SOLUTION. Hughston, L. P. (Princeton Univ., NJ); Penrose, R.; Sommers, P.; Walker, M. Commun. Math. Phys.; 27: No. 4, 303-8(1972).

Associated with the charged Kerr solution of the Einstein gravitational field equation there is a Killing tensor of valence two. The Killing tensor, which is related to the angular momentum of the field source, is shown to yield a quadratic first integral of the equation of the motion for charged test particles. (auth)

10716 COSMOLOGICAL EXPLANATION OF THE TREDER GRAVITATIONAL THEORY. Oleak, H. (Zentralinstitut fuer Astrophysik, Babelsberg, Ger.). Ann. Phys. (Leipzig); 28: No. 2, 189-92(1972). (In German).

A solution of the field equations is given for the case of a universe filled with incoherent matter (p = 0). The observable universe behaves kinematically in a good approximation like the Milne-model but with flat subspaces t = const. (auth)

10717 GRAVITATION. Thirring, W. (Univ., Vienna). Essays Phys.; 4: 125-63(1972).

Since the problem of gravitation was solved by Einstein in 1916 the knowledge of particles and their interactions has been increased to a great extent. In this paper the subject is discussed from the point of view of particle physics. An elementary discussion of theories of gravitation constructed according to the pattern of classical electrodynamics is given in which the equations of motion of particles and the field equations are derived from one action principle. The subject is dealt with in sections entitled; universality, weakness, thermodynamic behaviour of gravitating particles, life and death of stars, gravitational radiation, the equivalence principle, strong and weak equivalence, and a trip behind the Schwarzschild radius. (UK)

10718 DEPENDENCE OF MASSIVE SUPERPROPAGATORS ON THE STRONG AND WEAK GRAVITATIONAL COUPLING CONSTANTS. Leibbrandt, G. (Univ. of Guelph, Ont.). Can. J. Phys.; 50: No. 20, 2391-6(15 Oct 1972).

Numerical computations are presented for two massive superpropagators S_{fg} and S in terms of their respective coupling constants λ_g^2 and κ_f^2. S corresponds to the massive spin 2^+ f^0 meson, while S_{fg} represents the superpropagator for a mixed tensor field consisting of Einstein's massless gravity field $g^{\mu\nu}$ and the strong gravity field $f^{\mu\nu}$. It is found that both the general structure of S_{fg} and its asymptotic behavior in the ultraviolet limit, $S_{fg} \sim x^{12}$ as $|x^2| \to 0$, remain basically unchanged for couplings in the range 10^{-43} (BeV)$^{-2} \leq \lambda_g^2 \leq 10^{-36}$ (BeV)$^{-2}$. The same conclusion holds for the massive superpropagator S in the coupling interval 10^{-5} (BeV)$^{-2} \leq \kappa_f^2 \leq 10^0$ (BeV)$^{-2}$. All computations are carried out in Euclidean coordinate space. (auth)

10719 EINSTEIN EVOLUTION EQUATIONS AS A FIRST-ORDER QUASI-LINEAR SYMMETRIC HYPERBOLIC SYSTEM. I. Fischer, A. E.; Marsden, J. E. (Univ. of California, Berkeley). Contract AT(04-3)-34. Commun. Math. Phys.; 28: No. 1, 1-38(1972).

A systematic presentation of the quasi-linear first order symmetric hyperbolic systems of Friedrichs is presented. A number of sharp regularity and smoothness properties of the solutions are obtained. The case of R^n with suitable asymptotic conditions im-

posed is considered. As an example, this theory is applied to give new proofs of the existence and uniqueness theorems for the Einstein equations in general relativity, due to Choquet–Bruhat and Lichnerowicz. These new proofs using first order techniques are considerably simpler than the classical proofs based on second order techniques. The existence results are as sharp as had been previously known, and the uniqueness results improve by one degree of differentiability those previously existing in the literature. (auth)

10720 AUTOCORRELATION FUNCTION FOR INVERSE SQUARE FORCES. Ahmad, A.; Cohen, L. (Hunter Coll., New York). Phys. Lett.; 42A: No. 3, 243-4(4 Dec 1972).

Results of numerical experiments on the two time autocorrelation function for the inverse square force are presented and compared to the theory of Chandrasekhar. Indications are that for longer times it decreases faster than predicted by theory. (auth)

10721 CRITIQUE OF THE DIRECTIONAL SINGULARITY CONCEPT. Cooperstock, F. I.; Junevicus, G. J. G.; Wilson, A. R. (Univ. of Victoria, B. C.). Phys. Lett.; 42A: No. 3, 203-4(4 Dec 1972).

By considering a family of trajectories in a particular Weyl gravitational field, a class is found for which the scalar $R_{ijkl}R^{ijkl}$ becomes infinite in a direction of approach previously believed to be singularity-free. Further objection arises from the finiteness of the scalar in the singular region of another Weyl field. (auth)

10722 VARIATIONAL PRINCIPLE FOR ELASTIC EARTH MODELS WITH AN ARBITRARY INITIAL STATIC STRESS FIELD. Boschi, E. (Univ., Bologna). Lett. Nuovo Cim.; 5: No. 13, 859-64(25 Nov 1972).

A variational theorem is established for self-gravitating elastic configurations with an arbitrary initial static stress field, in the space of the original functions, starting from the reciprocity theorem. (L.B.S.)

Scattering Theory

Refer also to abstracts 10603, 10688, 10694, and 10699.

10723 (IFVE-STF-71-118) BOUNDS FOR THE DIFFERENTIAL CROSS-SECTIONS DEFINED BY THE NEAREST SINGULARITIES. Ezhela, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

Bounds for the differential cross sections $d\sigma_{el}(s,\theta)/d\cos\theta$ and $d\sigma_{inel}(s,\theta)/c\cos\theta$ at $s \to 0$ and $\theta = 0, \pi$ were obtained. (auth)

10724 CANCELLATION IN THE OFF-SHELL EIKONAL WATSON SERIES. Namyslowski, J. M. (Univ., Warsaw). Nuovo Cim.; 12A: No. 2, 321-40(21 Nov 1972).

An explicit evaluation of the off-shell 3-body scattering amplitude in the eikonal approximation shows that the first two terms of the Watson multiple-scattering series, i.e., terms corresponding to the single and double scattering, if averaged with a bound-state wave function, give the exact answer. It is found that

$$\langle \mathbf{p}'\mathbf{q}'|\tilde{U}_{\beta\delta}|\mathbf{p}\mathbf{q}\rangle_d = \langle \mathbf{p}'\mathbf{q}'|\tilde{T}_\alpha + \tilde{T}_\gamma - \frac{1}{(2\pi)^2\mu}(\tilde{T}_\alpha\tilde{G}_0\tilde{T}_\gamma + \tilde{T}_\gamma\tilde{G}_0\tilde{T}_\alpha)|\mathbf{p}\mathbf{q}\rangle_d$$

where

$$\langle \mathbf{p}'\mathbf{q}'|\tilde{U}_{\beta\delta}|\mathbf{p}\mathbf{q}\rangle_d \equiv \int d^3q' \int d^3q \psi_d^*(\mathbf{q}')\langle \mathbf{p}'\mathbf{q}'|\tilde{U}_{\beta\delta}|\mathbf{p}\mathbf{q}\rangle\psi_d(\mathbf{q})$$

$\tilde{U}_{\beta\delta}$ is the 3-body Lovelace scattering amplitude, and $\tilde{T}_\alpha$, $\tilde{T}_\gamma$ are 2-body scattering amplitudes, written in the 3-body space. All these amplitudes are calculated in the appropriate eikonal approximation. It is essential to have on the right-hand side of the formula the whole eikonal free Green's function, containing both the principal part and the δ-part. When the on-shell 3-body amplitude is calculated, the ordinary Glauber formula is obtained and the cancellation pointed out by Harrington is recovered. (auth)

10725 DAMA AND REGGE ASYMPTOTIC BEHAVIOUR. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A.; Shelest, V. P. (Inst. for Theoretical Physics, Kiev). Nuovo Cim.; 12A: No. 2, 377-86(21 Nov 1972).

The high-energy behavior of a dual amplitude with Mandelstam analyticity (DAMA) is investigated. A detailed analysis of the dependence of the asymptotic behavior of DAMA on the position of the boundary of the spectral function and on the asymptotic form of the Regge trajectory is given. It is proved that the amplitude does have Regge asymptotic behavior for arbitrary momentum transfers if the trajectories increase slower than s. (auth)

10726 COHERENT STATES OF ANGULAR MOMENTUM. Mikhailov, V. V. (Physical-Technical Inst., Kazan). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 975-83(Jun 1972). (In Russian).

By analogy with harmonic oscillator coherent states and taking into account the Schwinger representation of angular moment operators, coherent states are introduced. Some properties of these states such as an easy approach to the classical limit, uncertainty relations, completeness, changes under unitary transformations (rotations, action of external force) are investigated. A physical example of the spin motion in constant and variable magnetic fields is represented. It is shown that the angular moment coherent states of the second kind can be introduced. (auth)

10727 KINEMATIC THEOREM WITH MANY APPLICATIONS. Actor, A. (Univ. of Durham, Eng.). Lett. Nuovo Cim.; 5: No. 14, 902-4(2 Dec 1972).

A kinematic theorem is presented with applications in a wide range of covariant problems. The parametrization of two-body and N-body scattering amplitudes, helicity crossing relations for an N-body process, and an explicit parametrization of general spin propagators are some applications mentioned. (J.F.P.)

10728 SEPARABLE APPROXIMATIONS TO THE OFF-SHELL TWO-BODY t AND K MATRICES AT POSITIVE ENERGIES. Bolle, D. (Univ., Louvain, Belg.). Nuovo Cim.; 12A: No. 3, 651-64(1 Dec 1972).

By means of the connection between the Kowalski–Noyes representation and the Weinberg expansion of the two-body off-shell t-matrix, the slow convergence of the latter eigenfunction expansion at positive energies, even at resonances, can be explained in a natural way on the basis of earlier published results. It is also shown that this expansion is not necessarily term-by-term quasi-unitary. Based on these facts, the conclusion is drawn that the most suitable eigenfunction expansion at positive energies seems to be the K-matrix expansion, provided it is used in a K-matrix approach to the three-body scattering problem. (auth)

10729 IDENTITIES RELATED TO VARIATIONAL PRINCIPLES. Gerjuoy, E. (Univ. of Pittsburgh); Rau, A. R. P.; Spruch, L. J. Math. Phys. (N. Y.); 13: No. 11, 1797-1804 (Nov 1972).

The existence of a well known identity associated with variational principles for any scattering parameter Q, and often serving as the starting point for the development of a variational bound on Q, strongly suggests that it might be useful to construct identities associated with variational principles for quantities other than scattering parameters. An identity associated with the variational principle for the determination of inner products of the linear form $g^+\phi$, a generalization of the aforementioned identity, is presented. The g is a known function, and ϕ is an unknown function satisfying $M\phi = \omega$ and specified boundary conditions, where M is a known linear operator and ω is a known function. The generalized identity is obtained from a variational principle for $g^+\phi$, this variational principle being itself a generalization of the usual Kohn variational principle for scattering amplitudes and phase shifts. An identity associated with a variational principle for the quadratic form $\phi^+W\phi$ with ϕ as above and W a known linear operator, is also obtained. Finally, one obtains an identity for $\phi(\infty)$, where ϕ is defined as the solution of a nonlinear differential equation. The generalized identity related to $g^+\phi$ is verified for a simple exactly solvable problem. (auth)

10730 SL(2,R)-SYMMETRY OF THE DUAL TWO-PARTICLE AMPLITUDE. Popov, Kh. D.; Stoyanov, D. Ts.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 13: No. 2, 145-73(Nov 1972). (In Russian).

On the basis of the dispersion relations a Mellin-type integral representation for the crossing-symmetrical two-particle scattering amplitude is obtained. It is shown that duality is a consequence of some symmetry of the amplitude with respect to the irreducible unitary representation of the group SL(2,R). This symmetry allows one to write down an integral representation for the amplitude, which could be useful for combining duality and unitarity. (auth)

10731 LOCAL ANALYTICITY PROPERTIES OF THE n-PARTICLE SCATTERING AMPLITUDE. Bros, J. (CERN, Geneva); Glaser, V.; Epstein, H. Helv. Phys. Acta; 45: No. 2, 149-81(1972).

The connected part $F_c(p)$ of the scattering amplitude $\langle p_1 \ldots p_r|S-1|p_{r+1}, \ldots, p_n\rangle$ defined on the mass shell $p_i^2 = m_i^2$ and deduced from a local field theory involving only (stable) particles with strictly positive masses can be represented in a suitable neighborhood of any physical point p as a finite sum $f_c(p) = \Sigma_1^N F_i(p)$ of "partial amplitudes," each $F_i(k)$ analytic in a certain domain F_i of the complex mass shell $k_i^2 = m_i^2$. The mentioned real neighborhood lies on the boundary of each F_i. The above decomposition may fail to hold only at points p where any two incoming or any two outgoing four-momenta become parallel (thresholds). The number N as well

as the shape of the domains F_i depend on the number n and on the real neighborhood considered. For a generic configuration p the interaction of the domains F_i is empty. When this does not happen, $F_i(p)$ is the boundary value of a single analytic function. This is illustrated on the case of the five-point function, where it is shown that when $D \equiv \det(p_r p_s) > m_1^2 m_2^2 m_3^2$, D being the Gram determinant of the scalar products of the three outgoing momenta p_1, p_2, p_3, the scattering amplitude is the boundary value of a single analytic function. It is also indicated on the same example how these local results may be improved; one finds in the equal mass case $m_r = m$ that the five-point scattering amplitude is the boundary value of a single analytic function whenever $M > 4$, 8m, M being the total center-of-mass energy of the three outgoing momenta. (auth)

10732 HIGH-ENERGY APPROXIMATION FOR A QUASI-POTENTIAL AMPLITUDE. Tutik, R. S. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 2, 340-2(Feb 1972). (In Russian).

The quasi-potential scattering amplitude at high energies was investigated with the assumption of a purely virtual quasi-potential and in disregard of the real portion of the amplitude. In the quasi-potential equation, the substitution of the Green function corresponds to its δ-form part. The amplitude leads to a K-matrix in the representation of an impact parameter. The problem of unitarity and the realm of usefulness of the amplitude within the given assumption were examined. (tr-auth)

10733 ANALYTICAL PROPERTIES OF NONRELATIVISTIC SCATTERING AMPLITUDES. Chadan, K. (Paris Univ., Orsay, France). pp 1.1-1.87 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

The various analytical properties of quantities having loose or strong connections with the description of the physical phenomena observed in scattering experiments are described. (France)

10734 PHENOMENOLOGICAL MODELS AND ANALYTICAL PROPERTIES IN THE ANGULAR MOMENTUM COMPLEX PLANE. Salin, P. (Bordeaux Univ., Gradignan, France). pp 4.1-4.23 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

The analytical properties of the scattering amplitude in the angular momentum complex plane are reviewed. These properties are compared with those of phenomenological models (in particular those based on Regge poles). (France)

10735 DUALITY. Le Bellac, Michel (Univ., Nice). pp 6.1-6.25 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

After having reviewed the experimental facts suggesting duality, the basic hypotheses on duality are presented. Classical duality is then studied together with the relation between duality and helicity conservation, and duality and inclusive reactions. (France)

10736 INTRODUCTION TO AXIOMATIC DUALITY. Gervais, J. L. (Paris Univ., Orsay, France). pp 7.1-7.34 of Strong Interactions. /Renard, F. M. (ed.). Montpellier, France; Univ. of Montpellier (1971). (In French).

From National conference on theoretical physics; Montpellier, France (3 May 1971). See CONF-710558.

The program developed from the Veneziano model for determining the S matrix from duality properties (introduced as basic axioms) is presented. (France)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

10737 (COO–1569-90) THERMODYNAMIC PROPERTIES OF LIQUID ^{3}He/^{4}He MIXTURES NEAR THE TRICRITICAL POINT DERIVED FROM SPECIFIC HEAT MEASUREMENTS. Islander, S. T. (Technical Univ. of Helsinki, Otaniemi (Finland). Dept. of Technical Physics); Zimmermann, W. Jr. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1971. 10p. (CONF-720833–21). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Previously, the results of some measurements of the specific heat of liquid ^{3}He–^{4}He mixtures at saturated vapor pressure near the junction of the lambda and phase-separation curves were presented. Here, some of the possibilities for determining a variety of thermodynamic information about the junction region from the specific heat data are indicated. Numerical calculations of the quantities $(\partial s/\partial T)_{P,x} = c_{P,x}/T$, $(\partial\phi/\partial T)_{P,x} = -(\partial s/\partial x)_{P,T}$, s, and $\phi - \phi_0$ were made in the junction region as functions of T and x at saturated vapor pressure. (M.H.R.)

10738 (NP–19609) DAMPING OF ACCELERATED SUPERFLUID HELIUM FLOW BY ROTON POLARIZATION. Note No. 395. Calvani, P.; Greulich, R.; Maraviglia, B. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 20 Jul 1972. 13p. Dep. NTIS (U. S. Sales Only).

Any accelerated isothermal superfluid flow is shown to be damped, because work is done by the velocity field to increase the roton polarization. Energy is not regained if rotons depolarize successively. Two independent ways of demonstrating this assertion are presented. The model was applied to oscillation of two baths coupled via film, and it fits both the absolute value and the temperature dependence of the measured damping very well. (auth)

10739 FIELD-THEORETIC MODEL FOR THE CRITICAL BEHAVIOR OF ^{4}He ABOVE THE LAMBDA POINT. de Pasquale, F. (Univ., Rome); Tombesi, P. Nuovo Cim.; 12B: No. 1, 43-57(11 Nov 1972).

It is shown that the critical behavior of ^{4}He above T_λ can be described in terms of a peculiar solution of a set of approximate equations related to a field-theoretic model describing a system of bosons interacting via a "phononlike" field. The basic set of equations is derived by means of rather general physical arguments from an exact set of identities of the theory. The solution which describes the critical behavior is only asymptotically valid if an "effective coupling constant", associated with the model, reaches a nontrivial "fixed point" as the correlation length goes to infinity. In the asymptotic region the well-known scaling law $d\nu + \alpha = 2$ is derived. The nontrivial fixed point y_F, the rate of approach to the asymptotic region b and the critical index ν are calculated with an approximate method. The results are functions of the dimensionality parameter $\epsilon = 4 - d$ for $\epsilon > 0$. For dimensionality $d > 4$ the expected classical critical behavior is recovered. The best estimate is $y_F \simeq 0.11$, $b \simeq 4\epsilon$, $\nu = 1/(2[1 - \epsilon(1 - y_F)/4])$. These results are not derived with an expansion in the parameter ϵ but involve an approximation that presumably is equivalent to neglecting terms of the order of the critical index η. In three dimensions this gives $\nu \simeq 0.643$. A peculiar feature of the results is that the fixed point y_F does not depend either on the physical parameters of the theory or on the dimensionality of the system, but it depends on the topological structure of the diagrams. (auth)

10740 LIQUID HELIUM EXPERIMENTS WITH MICRON-SIZE ORIFICES. Schofield, G. L. Jr. Ann Arbor, MI; Univ. of Michigan (1972). 99p. University Microfilms Order No. 72-29,195.

Thesis.

A completely sealed experimental cell was employed at ^{3}He temperatures to investigate the analog of the ac Josephson effect in superfluid helium and to study superfluid critical velocities. At these low temperatures normal fluid effects are eliminated and any vortices produced will have much longer ranges than at the ^{4}He temperatures. The cell consisted of two reservoirs, each in the form of a coaxial capacitor, connected only by a μm size orifice. Differences in the liquid levels in the two reservoirs and sound fields near the orifice are produced by subjecting the liquid in one of the reservoirs to dc and ac electric fields. Level changes and flow through the orifice at critical velocities could be produced by applying a dc voltage step function to the cell. Constant subcritical velocities could be produced by using a square-root-of-time voltage ramp. The liquid level measuring equipment could detect changes in the liquid level as small as 10^{-4} cm, with a response time of 0.01 sec. The ac and dc dielectric pumping was found to agree with theory except at certain values of the frequency, associated with acoustic resonances. The presence of the ac Josephson effect was never detected. Attempts to reproduce the Richards–Anderson experiment also failed. The measured superfluid critical velocities could be divided into two mutually exclusive regimes. Extrinsic critical velocities occurred for the larger orifices. These velocities were low, weakly temperature dependent and not reproducible. Intrinsic velocities occurred for the smaller orifices. These were high and markedly temperature dependent, increasing with decreasing temperature. The highest velocity measured was 1000 cm/sec. The intrinsic velocity at the high temperature end of this study agrees with that at the low temperature of Hess's study. (Diss. Abstr. Int., B)

10741 SHOCK-WAVE GENERATION IN HELIUM GAS BY FAST EVAPORATION OF A SUPERFLUID HELIUM FILM. Bakker, J. W. M.; Van Kempen, H.; Salemink, H. W. M.; Wyder, P. (Univ. of Nijmegen, Netherlands). Phys. Lett.; 42A: No. 3, 193-4(4 Dec 1972).

The generation and detection of shock waves in cold helium gas by means of exploding superfluid helium films and superconducting tunnel junctions is described. The method can also be used to study the properties of superfluid films. (auth)

10742 LIGHT SCATTERING FROM SUPERFLUID HELIUM BY THERMAL SURFACE WAVES. Wagner, F. (Technische Univ., Munich). Phys. Lett.; 42A: No. 3, 265-6(4 Dec 1972).

The temperature dependence of the intensity of light scattered by thermal surface waves on liquid He II was measured between 1.29 and 2.14 K. The results can be explained by the same theory, which is valid for classical liquids. (auth)

10743 ELECTRON ESCAPE FROM NEGATIVELY CHARGED VORTEX RINGS INCIDENT ON THE FREE SURFACE OF He II. Mitchell, R. P.; Rayfield, G. W. (Univ. of Oregon, Eugene). Phys. Lett.; 42A: No. 3, 267-8(4 Dec 1972).

It is proposed that an electron tunnels into the vapor from the electronic bubble trapped on the vortex ring. A measurement of the electron energy in the vapor yields the ground state energy of the electronic bubble. (auth)

Superconductivity

Refer also to abstracts 11212 and 11229.

10744 (AD–743442) SUPERCONDUCTING TUNNELING IN SINGLE-CRYSTAL THIN FILMS. Final Report. Mitchell, E. N. (North Carolina Univ., Chapel Hill. Dept. of Physics). Mar 1972. 9p. (AFOSR-TR–72-963). NTIS.

Superconducting and Fermi-surface properties of single-crystal thin films using tunneling techniques were investigated. Emphasis was placed on studying these characteristics experimentally as a function of orientation. The Fermi velocity was determined by studying the observed Tomasch oscillations. Most of the work was performed on films grown by epitaxy on alkali halide substrates. The study was confined to aluminum, tin, and lead. (auth)

10745 (BNL–17232) COHERENT BEHAVIOR IN JOSEPHSON JUNCTION ARRAYS. Saxena, A. (Brookhaven National Lab., Upton, N. Y. St. John's Univ., Jamaica, NY, (USA)); Crow, J. E.; Strongin, Myron (Brookhaven National Lab., Upton, N. Y.). [nd]. 11p. Dep. NTIS.

Experiments are described on a Josephson junction array, made by compressing small particles, which apparently shows cooperative behavior. Samples were prepared by evaporating Al in a helium atmosphere, producing particles of about 100- to 500-Å diameter. One observation is that of a steady zero-bias dc voltage across the sample when rf power is incident upon it. (M.H.R.)

10746 (BNL–17240) SUPERCONDUCTING PROPERTIES OF CRYSTALLINE FILMS OF ALUMINUM ON SILICON. Strongin, Myron; Kammerer, O. F.; Farrell, H. H.; Crow, J. E. (Brookhaven National Lab., Upton, N. Y.). [nd]. 11p. Dep. NTIS.

Superconductivity in well-ordered and well characterized ultrathin epitaxial Al films on silicon was investigated. The transition temperature of the Al films is not very much higher than the bulk value, even down to thicknesses near 30 Å. Films evaporated with

more gas have higher T_c's and films oxidized by exposure to air also have increased T_c's. Films grown epitaxially have lower $R_\square$'s than films that are less crystalline. Although the higher resistance have broader transitions, the T_c's are the same. Results are shown and discussed. (M.H.R.)

10747 (COO-3151-16) FLUCTUATION CONTRIBUTION TO THE FAR INFRARED TRANSMISSION OF LEAD FILMS. Tanner, D. B. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Oct 1972. 40p. Dep. NTIS.

The transmission in the far infrared (2 to 40 cm^{-1}) of dirty, very thin lead films was measured in the vicinity of the transition temperature, T_c. The films were evaporated onto quartz substrates at or below 40°K and were not warmed above this temperature between the evaporation and the transmission measurements. The resistances of the films were monitored simultaneously with the far-infrared measurements. The transmission of the films is reduced at the lowest frequencies (below 5 cm^{-1}) corresponding to an increase in the ac conductivity. The results are well described by theoretical conductivities which give a characteristic frequency of the fluctuations, $\omega_F = [(16k_B T/\pi_h)(|T-T_c|/T_c)]$, both above and below T_c. (auth)

10748 PROPERTIES OF LOCALIZED BOUND STATE AND IMPURITY BAND IN SUPERCONDUCTING MAGNETIC ALLOYS. Shibata, Fumiaki; Machida, Kazushige (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 752-7(Sep 1972).

The change of the density of states of a superconductor due to a magnetic impurity is calculated taking into account the presence of the bound state. The method of the anomalous Green function, which was used to obtain the position of the bound state in a previous paper, is also used. It is shown that the bound state is represented by two delta functions. In the case of the finite concentration of impurities, the bound state is shown to have a finite width, forming the impurity band: The width becomes larger as the concentration increases, but an intermediate situation is encountered between the complete nonmagnetic system and the complete magnetic one. (auth)

10749 FUNCTIONAL INTEGRAL METHOD ON SUPERCONDUCTING CRITICAL PHENOMENA. II. A ZERO-DIMENSIONAL SUPERCONDUCTOR. Takayama, Hajime (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 758-65(Sep 1972).

Using the functional integral method developed in a previous work, critical phenomena in a small superconducting particle are examined in the whole temperature range. It is shown that the mean square value of fluctuation becomes of the order $(p_0R)^{-1}$ $(\xi_0/R)^{1/2}$ just at the transition point, R being a radius of the particle, ξ_0 the BCS coherence length and p_0 the Fermi momentum. (auth)

10750 PHENOMENOLOGICAL MODELS OF ELECTRON-PHONON INTERACTION AND CRITERIA OF METAL SUPERCONDUCTIVITY. Pashitskii, E. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 889-902(Jun 1972). (In Russian).

On the basis of the isotropic phenomenological model (which is a generalization of models of Pines and Kulik) in the strong-coupling approximation, a formula is obtained for critical temperature of the superconductive transition T_c and a numerical analysis is made of T_c dependence on elastic lattice constants (sound velocity) and electron concentration (number of free electrons per atom). It is shown that theoretical values of critical temperature and isotope shift index $\nu = -\partial \ln T_c / \partial \ln M$ are in satisfactory quantitative agreement with experimental values of T_c and ν for most nontransition metals, and the dependence of T_c on the concentration of conduction electrons is in qualitative agreement with the empirical dependence of the superconductive transition temperature on the average number of valence electrons in melts of solid-solution type. A criterion of superconductivity is suggested which is valid practically for all the considered metals, except for alkali metals (Li, Na, K) that are characterized by strong anisotropy of the lattice elastic properties. (auth)

10751 EFFECT OF IMPURITIES ON SUPERCONDUCTIVITY IN ANDERSON MODEL. PERTURBATIONAL TREATMENT. Inoue, Chuya; Takano, Fumihiko (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 4, 1080-9(Oct 1972).

The Green function for s-electrons is calculated perturbationally with respect to the mixing interaction in order to investigate the Kondo effect in the Anderson model in superconductors. By taking the limit $U \to \infty$, it is shown that, at least to the lowest order, any singularity does not occur in the nonmagnetic case ($E \gg T$), and that the singularity in the magnetic case ($E < 0$, $|E| \gg T$) is of a little different form from that of the s-d exchange model. In the nonmagnetic case, the initial decrease of superconducting transition temperature is calculated perturbationally by taking the value of U finite and the result is compared with that of the Hartree-Fock approximation. (auth)

10752 MAXIMUM EQUILIBRIUM CURRENT IN COMPOSITE SUPERCONDUCTORS. Sychev, V. V.; Zenkevich, V. B.; Al'tov, V. A. (Inst. of High Temperatures, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 1023-8(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1288-95(Jun 1972).

The concept of maximum equilibrium current of a composite superconductor was introduced on the basis of an analysis of the conditions of thermal equilibrium in the superconductor at temperatures above the critical value, taking account of the temperature dependence of the substrate resistance. At currents exceeding this characteristic current the superconductor has no equilibrium states when $T > T_c$ and if I = const the current-carrying winding can burn out. A relation is derived for determining the maximum equilibrium current I*. The theoretical conclusions are confirmed by experimental data. It is shown that several known failures in superconducting magnetic systems took place when the maximum equilibrium current was exceeded. (auth)

10753 INFLUENCE OF FLUCTUATIONS ON THE ELECTROMAGNETIC PROPERTIES OF THE JOSEPHSON TUNNEL JUNCTION. Kalashnik, L. I.; Kislov, A. M.; Kulik, I. O.; (and others) (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 1029-35(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1296-1305(Jun 1972).

The manifestations of nonstationary quantum interference in Josephson tunnel junctions when fluctuations are taken into account are investigated. The Langevin and Fokker-Planck equations are solved with allowance for the radiation field. The solution makes it possible to reconstruct the voltage-current characteristic and the singularities produced on the characteristic by the external radiation. It is shown that the dynamic conductivity (slope of the voltage-current characteristic at zero) oscillates as a function of the amplitude of the external alternating signal. (auth)

10754 PROXIMITY EFFECT IN PARALLEL MAGNETIC FIELDS. Todd, R. J. Detroit; Wayne State Univ. (1972). 156p. University Microfilms Order No. 72-28,497.

Thesis.

The parallel critical magnetic field of normal-superconducting layered samples was investigated. The experimental results were compared with the predictions of two recent theories. Two separate cases were considered. In the thick superconductor limit, the thickness of the superconducting layer (d_s) was greater than twice the temperature-dependent coherence length ($2\xi_s(T)$), for all temperatures of interest. In the thin superconductor limit ($d_s < 1.84\xi_s(T)$), the ratio d_s/ξ_s was controlled via the temperature-dependent coherence length and the initial thickness, d_s. The comparison of the experimental results with the theories allowed definite conclusions to be made regarding the validity of the assumptions of the theories. In particular, the boundary conditions imposed on the order parameter at the normal-superconducting interface were carefully examined in light of the experimental results. (Diss. Abstr. Int. B)

10755 FLUX MOTION IN LEAD-INDIUM WIRES WITH LONGITUDINAL MAGNETIC FIELDS. Nicholson, J. E. Norman, OK; Univ. of Oklahoma (1972). 114p. University Microfilms Order No. 72-29,905.

Thesis.

Magnetic flux lines appear in a type-II superconducting wire when it is put in the mixed state by a longitudinal magnetic field B_z. In the presence of a transport current J, the helical flux lines experience a Lorentz force, $F_L = J \Phi_0 \sin\theta$. Flux motion occurs when J, producing an azimuthal field B_w, exceeds a certain critical value. For cylindrical geometry, $\sin\theta \simeq B_w/B_z$ (for small angles) and the flux lines are helices. When the Lorentz force dominates the pinning force caused by both surface and bulk defects, viscous flow occurs and $V \propto {}^3I$, unlike the slab geometry in a transverse field where $V \propto I$. Theoretical analysis (by two models) achieved by equating power input to power dissipated gives $V \propto {}^3I$ and allows us to solve for pinning forces and for resistivities. (Diss. Abstr. Int., B)

10756 INDUCED VOLTAGE IN CURRENT-CARRYING SUPERCONDUCTING THIN FILMS IN SUPERIMPOSED ac AND dc MAGNETIC FIELDS: A STUDY IN THE RADIO-FREQUENCY AND MICROWAVE-FREQUENCY RANGES. Friedman, E. J. Detroit; Wayne State Univ. (1972). 122p. University Microfilms Order No. 72-28,432.

Thesis.

A study was made of a modulation effect of the power absorption in superconducting thin films of lead and tin. The modulation was provided by an ac magnetic field and a measurement was made of both the amplitude and the phase of the modulation waveform. It was found that the phase of the modulation changed by approximately 180°, depending on the magnetic history of the

sample. A model describing this phase-reversing aspect of the results is suggested for the case where the films were carrying currents of a microwave frequency. This model is based on the concepts of induced surface currents and the voltages generated by the motion of flux in superconductors. Under the appropriate conditions the model predicted the existence of the phase shift. A discussion is also provided concerning the general features of the radio frequency data and its relation to the microwave results. (Diss. Abstr. Int., B)

10757 ANOMALOUS TEMPERATURE DEPENDENCE OF THE THERMAL-EXPANSION COEFFICIENTS OF SUPERCONDUCTING NIOBIUM AND TANTALUM CARBIDES. Boiko, A. A.; Kodess, B. N.; Shekhtman, V. Sh. (Inst. of Solid-State Physics, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 3, 599-600(1972).

Translated from Kristallografiya; 17: No. 3, 683-4(1972).

An x-ray study was made of the thermal expansion of $NbC_{0.95}$ and $TaC_{0.90}$ at 90 to 300°K. The results show rapid increases by a factor of 2.5 to 3 over a narrow temperature range of 60 to 70°. (D.L.C.)

10758 NATURE OF SOLID SOLUTIONS BASED ON SUPERCONDUCTING V_3Si. Kopetskii, Ch. V.; Kodess, B. N.; Marchenko, V. A. (Inst. of Solid State Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1556-7(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1804-6(Jun 1972).

The lattice constant a, the superconducting transition temperature T_c, and the density were measured for solid solutions based on V_3Si. The composition was varied from 17 to 28 at. % Si. The solid-solution region was found to extend from 20.5 ± 0.5 to 24.5 ± 0.5 at. % Si. T_c increased with Si content, reaching 17°K at 24.5 at. % Si. The excess V atoms occupy some of the sites in the Si sublattice, and the number of the remaining vacancies vary linearly with the excess V. The linear chain model is of limited use in explaining the electronic properties; the interaction between the V atoms and the Si sublattice must be taken into account. (D.L.C.)

10759 MOESSBAUER EFFECT AND SUPERCONDUCTIVITY OF TIN UNDER PRESSURE. Panyushkin, V. N.; Yakovlev, E. N. (Inst. of High-Pressure Physics, Podolsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1579-80(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1825-6(Jun 1972).

The McMillan model (Phys. Rev. 167: 331(1968)) is used to predict the pressure dependence of T_c: $T_c \propto \langle\omega\rangle \exp(1 + \lambda/\mu^* - \lambda)$, where λ is the electron–phonon interaction constant and μ^* is the Coulomb repulsion between electrons. $\lambda = (C/M\langle\omega^2\rangle)$, where $\langle\omega^2\rangle$ and $\langle\omega\rangle$ are the moments of the phonon spectrum. The measured probability of the Moessbauer effect under pressure is used to estimate the pressure dependence of the moments of the phonon spectrum of β Sn. The calculated T_c vs p curve is in agreement with experimental data up to the phase transition at 100 kbar. The T_c change due to the transition to Sn II is estimated to be an increase of ~1°K; the discrepancy with the actual rise to ~5°K is probably due to changes in the parameters C and μ^*. (D.L.C.)

10760 RELATION BETWEEN TEXTURE AND CRITICAL CURRENT DENSITY IN SUPERCONDUCTING TITANIUM–NIOBIUM ALLOYS WITH ADDITION OF ALPHA STABILIZERS. Rassmann, Guenther; Illgen, Lothar (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Neue Huette; 17: No. 9, 547-53(Sep 1972). (In German).

The additives oxygen, nitrogen, carbon, and aluminum were studied with respect to their effect on the critical current density in superconducting titanium–niobium alloys. Oxygen, nitrogen, and carbon caused an increase in the critical current density (4.2°K, average fields around 50 kOe); aluminum additions reduced the jc values. (tr-auth)

10761 INFLUENCE OF COPPER COATING THICKNESS ON THE CRITICAL CURRENT IN SUPERCONDUCTING WIRE OF NOBIUM ALLOYS. Lazarev, B. G.; Goridov, S. I. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 206: No. 1, 85-6(1 Sep 1972). (In Russian).

The critical current density in the alloys Nb–60 at.% Ti and Nb–25 at.% Zr–25 at.% Ti was studied as a function of the thickness of a copper coating. The superconducting properties improved as the Cu coating was increased from 0 to 10 μ, and thereafter an increase up to 120 μ did not affect them. (K.S.W.)

10762 NEW EFFECT OF a.c. FIELDS AND a.c. CURRENTS IN TYPE-II SUPERCONDUCTORS. Delrieu, J. M. (CEN de Saclay, Gif-sur-Yvette, France). Solid-State Commun.; 11: No. 11, 1557-61(1 Dec 1972).

A new effect in a type-II superconducting alloy $Pb_{75}Tl_{25}$ with ac currents is reported: the critical current I_c is smaller in increasing current than in decreasing current, only if the current oversteps I_c in both opposite directions. The disappearance of I_c with ac fields is in good quantitative agreement with a theoretical explanation: the induced electric field is rectified by the nonlinear static voltage–current characteristic so that the critical current seems to decrease. (auth)

10763 PRESSURE INDUCED SUPERCONDUCTIVITY IN CESIUM. Stocks, G. M.; Gaspari, G. D.; Gyorffy, B. L. (Oak Ridge National Lab., TN). J. Phys., F (London); 2: No. 6, L123-8(Nov 1972).

Pressure induced variations in the electron–phonon coupling constant λ of cesium are calculated from first principles. It is found that λ increases with pressure and it is predicted that cesium should be superconducting with an observable transition temperature T_c at 35 kbar. (auth)

10764 AC LOSS AND RELATED EFFECTS IN TYPE 2 SUPERCONDUCTORS. Melville, P. H. (Central Electricity Research Labs., Leatherhead, Eng.). Advan. Phys.; 21: No. 92, 647-89(Jul 1972).

Information important to the understanding of superconducting materials under ac conditions is gathered together; some features which are at present not too well understood are pointed out. The idea is to try to build a consistent picture of the performance of superconductors rather than to present a historical account of the subject. The basic behavior of fluxons in the bulk of type-II superconductors can be explained by the critical state model, but some of the details of flux pinning and the method of flux motion are in doubt. Flux instabilities under dc conditions have received a lot of attention and so have the methods of stabilization, but instabilities under ac conditions have not been studied in so much detail, and the problem of stabilization is more difficult than for dc. Generally, surface effects are less well understood than bulk effects, partly because there are a number of possible phenomena to contend with. Ac loss in the Meissner state can be explained by field enhancement and flux penetration at peaks in the surface. For fields between H_{c3} and H_{c2} present solutions of the Ginzburg–Landau equations for the currents in the surface sheath do not give sufficient agreement with experiment and some alternative explanation, such as flux pinning, may be necessary. There are a number of effects between H_{c2} and H_{c1}, but the most important are Meissner currents and flux pinning. (auth)

10765 AC CONDUCTIVITY OF THIN SUPERCONDUCTING FILMS IN THE TRANSITION REGION. Bray, A. J.; Rickayzen, G. (Univ. of Kent, Canterbury, Eng.). J. Phys., F (London); 2: No. 6, 1114-23(Nov 1972).

The ac conductivity of a thin superconducting film in the transition region is calculated using a Hartree like bilinearization of the Ginzburg–Landau theory. A single expression is obtained which reduces above T_c to the fluctuation conductivity found by Schmidt (Z. Phys.; 216: 336-45 (1968), and 232: 443-51 (1970)) and below T_c to the low frequency limit of the Mattis–Bardeen result (Phys. Rev.; 111: 412-7 (1958)). Good agreement with experiment is found. (auth)

10766 NONLINEAR EXTERNAL FIELD EFFECTS IN QUASI-SUPERCONDUCTING FILMS. Parisi, G. (CNEN, Frascati, Italy). Phys. Lett.; 42A: No. 3, 233-4(4 Dec 1972).

Using an improved Hartree–Fock approximation on the Landau–Ginzburg equation, the extra conductivity is computed for quasi-superconducting thin films near the phase transition in the nonlinear region. (auth)

10767 EXPERIMENTAL CHECK OF NONLINEAR EFFECTS IN Al THIN FILMS CLOSE TO T_c. Lucano, G. (Univ., Rome); Pace, S.; Romani, G. L.; Parisi, G. Phys. Lett.; 42A: No. 3, 235-6(4 Dec 1972).

An experimental verification is reported for a theoretical predicted nonlinear electric field dependence of the extraconductivity in Al thin films very close to T_c. (auth)

10768 PRESSURE DEPENDENCE OF THE TRANSITION TEMPERATURE OF SUPERCONDUCTORS WITH Ce IMPURITIES. Maple, M. B. (Univ. of California, San Diego). Phys. Lett.; 42A: No. 3, 247-8(4 Dec 1972).

As a result of the extreme sensitivity of the magnetic state of the Ce ion to pressure, rather striking variations of the superconducting transition temperature T_c with pressure can be expected of certain matrix–Ce impurity system when $T_K/T_{c_0} \ll 1$ (T_K is the Kondo temperature and T_{c_0} is the T_c of the matrix). In this limit, recent theories have predicted three T_c's for alloys within a given range of Ce impurity concentration. It is shown that the application of pressure may raise the yet unobserved third T_c to an experimentally accessible temperature. (auth)

10769 MAGNETIC HYSTERESIS STUDIES OF SUPERCONDUCTING BETA STABILIZED TITANIUM ALLOYS. Luhman,

T. S.; Taggart, R.; Polonis, D. H. (Univ. of Washington, Seattle). Scr. Met.; 6: No. 11, 1055-60(Nov 1972).

A Ti–20 at.% Nb and a Ti–28% V alloy were used to investigate the effects of alpha- and omega-phase precipitation on magnetic hysteresis and the parameter H_{c2}. The superconductivity experiments also included an examination of the phase-separation reaction and the omega reversion processes reported previously. (M.H.R.)

10770 ROTATING FIELDS AND FLUX PINNING. Gilchrist, J. le G. (Centre National de la Recherche Scientifique, Grenoble, France). J. Phys., D (London); 5: No. 12, 2252-65(Dec 1972).

Bean (Rev. Mod. Phys., 36: 31-9(1964) and J. Appl. Phys., 41: 2482-3(1970)) gave a solution to the problem of a mixed-state superconductor in a rotating field. This was a quasi-static critical-state solution. In the present paper it is shown how, when the product of the frequency and the square of the amplitude of the rotating field exceeds a certain value, Bean's solution must be modified to take account of dynamic effects (flux creep and flux flow). For isotropic materials the rotating-field problem is simpler than the alternating-field problems, and certain exact solutions can be found covering the entire range from critical-state to flux-flow conditions. There follows a discussion of the low-amplitude response, which requires a special description differing from the critical state and from the flux-flow state. A review is given of the analogous alternating-field problems elaborating some ideas put forward by Campbell (J. Phys. C., 4: 3186-98(1971)). The approach throughout is macroscopic and phenomenological, and the problem is reduced to its simplest form so as to involve a minimum number of variables. (auth)

Equipment and Devices

Refer also to abstracts 9598 and 10741.

10771 (COO–3169-12) FLUX FLOW MEMORY SWITCH. Report No. 1784. Putz, A. G.; Steingart, M.; Kramer, E. J. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). [ndl. 5p. Dep. NTIS.

A memory switch, based on the multiple-valued voltage–current characteristic of a plastically deformed type-II superconductor, is described. Switching to the nonzero voltage ("on") state is accomplished with a current pulse sufficient to cause flux flow, which presumably disrupts the pin matching and/or perfection of the flux-line lattice (FLL). The minimum current pulse duration to cause this switching is ~100μs at a peak electric field of 4μV/cm. Switching back to the zero voltage ("off") state is accomplished by sending a current pulse sufficient to heat the crystal above the critical temperature $T_c(H)$. In the experiments, heating was principally at a resistive spot weld in series with the crystal and in good thermal contact with it. (auth)

10772 (LBL–1136) APPLICATION OF THE SHUNTED JUNCTION MODEL TO POINT CONTACT JOSEPHSON JUNCTIONS. Taur, Y.; Richards, P. L.; Auracher, F. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 10p. (CONF-720833–25). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO (20 Aug 1972).

The dc I–V characteristics of oxidized Nb/Nb point contacts were studied as a function of temperature, contact pressure, and rf power at 36 GHz. Results for junctions which do not show hysteresis were compared in detail with calculations from the resistively shunted junction (RSJ) model. The agreement between the data and the RSJ model, with a constant shunt resistance and including the effects of noise, is significantly better than has been reported for Dayem bridges. (M.H.R.)

10773 (LBL–1150) INDIUM-BARRIER-INDIUM TUNNELING JUNCTIONS. Jack, M. D.; Rochlin, G. I. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 9p. (CONF-720833–23). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO (20 Aug 1972).

High-quality In/insulator/In tunnel junctions were successfully produced with resistances at 4°K varying from .01 ohms to .01 gigaohms. Many of the typical good tunneling junction characteristics were observed, and additional information concerning the In phonon density of states and the effect of strong coupling on the magnitude of the Josephson current was obtained. In addition, anomalously high resistance junctions were produced, which are physically very interesting and may very well have thin-film-circuitry applications. (M.H.R.)

10774 (LNF–72/29) STUDY ON DIMENSIONS OF DIRECT-CURRENT HOMOPOLAR SUPERCONDUCTING MACHINES. Pasotti, G.; Veca, G. M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 31 Mar 1972. 20p. (In Italian). Dep. NTIS (U. S. Sales Only).

A schematic diagram of a homopolar superconducting machine is given. The morphology of the machine is examined with a determination of the field map, determination of E and optimization of r_i, and determination of the power and scale factors. Problems connected with the inductor magnet and the rotor are considered. Cost factors are discussed and criteria for the selection of the form and dimensions for a machine with preset power between 1 and 100 MW are given. (J.S.R.)

10775 (RPP/A–93) FILAMENTARY SUPERCONDUCTORS FOR PULSED MAGNETS. Thomas, D. B.; Wilson, M. N. (Rutherford High Energy Lab., Chilton (England)). Sep 1972. 5p. (CONF-720908–18). Dep. NTIS (U. S. Sales Only).

From 4. international conference on magnet technology; Upton, NY. (19 Sep 1972).

The present stage in the development of superconducting composites and cables intended for use in pulsed magnets and based on niobium–titanium is described. The principal formulas for calculating ac losses are quoted and some numerical examples are given. (auth)

10776 JOSEPHSON EFFECT IN SUPERCONDUCTIVE TUNNELING STRUCTURES. Kulik, I. O.; Yanson, I. K. New York; John Wiley and Sons, Inc. (1972). 192p. $20.00. (IPST-Cat.–2231).

Translated from Russian by P. Gluck.

The theory of the Josephson effect is covered, including steady- and nonsteady-state Josephson currents and electrodynamic effects. The theory of the current–voltage characteristic of the effect is discussed, as well as the problem of one-dimensional vortex structures. Quantum interference effects connected with the Josephson effect are also considered. Experimental results are covered. The characteristics of stationary and nonstationary Josephson currents are discussed and methods for preparing tunneling contacts are described. A description is given of the use of the effect in experimental techniques, the study of the nature of Josephson electromagnetic radiation, and the interaction of alternating Josephson currents with external electromagnetic radiation. (M.H.R.)

PHYSICS (NUCLEAR)

10777 (ORO–2972-226(Task 1)) RESEARCH IN EXPERIMENTAL NUCLEAR PHYSICS. Progress Report No. 11, December 1, 1971–November 30, 1972. Zaidi, S. A. A. (Texas Univ., Austin. Center for Nuclear Studies). 4 Dec 1972. Contract AT(40-1)-2972. 120p. Dep. NTIS.

Research in experimental nuclear physics conducted by the faculty, staff, and students of the Center for Nuclear Studies, supported in whole or part by the Division of Research of the United States Atomic Energy Commission, has generated during 1972 an impressive record on many levels. There have appeared 42 referred journal papers in print, 25 submitted papers not yet in print, and 15 abstracts since last year's progress report. The research faculty of the Center has delivered 15 invited talks at various conferences and during visits to other facilities. Further, 4 M.A. and 4 Ph.D. degrees were awarded to graduate students working in the Center during the same period. The research in nuclear structure and nuclear reaction mechanisms, and in X-ray studies of atomic ionization by heavy-ion bombardment, remains in the forefront of basic nuclear and atomic physics, yet are broadly applicable to practical technological problems. (auth)

Neutron Interactions with Matter

Refer also to abstract 11184.

10778 (BNL–17408) PROGRAM INTER. Ozer, O. (Brookhaven National Lab., Upton, N. Y.). Feb 1972. 22p. Dep. NTIS.

The INTER program calculates the Maxwellian averaged cross section, the thermal cross section, the g-factor, and the infinite dilution resonance integral of an ENDF material. INTER is written in FORTRAN IV and may be made machine independent by replacing the TTYIN input subroutine by a single read statement. (J.W.R.)

10779 (CONF-720701–(Absts.), pp 4-5) NEUTRON INELASTIC SCATTERING FROM SATURATED AND SUPERHEATED WATER VAPOR MOLECULES. Sefidvash, F. (Arya-Mehr Univ., Tehran). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10780 (CONF-720701-(Absts.), pp 68-9) AVERAGE CROSS SECTIONS FOR Pu-α-Be NEUTRONS: LOW ENERGY NEUTRONS FROM α-n SOURCES. Peto, G.; Csikai, J.; Shuriet, G. M.; Jozsa, I.; Asztalos, V. (Kossuth Univ., Debrecen, Hungary). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10781 (RT/FI–(72)27) UTOE: AN UKNDL TO ENDF/B TRANSLATION PROGRAMME. Panini, G. C. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). 12 Jul 1972. 58p. Dep. NTIS (U. S. Sales Only).

UTOE (UKNDL to ENDF/B) is a program written in FORTRAN IV which performs the automatic translation of evaluated nuclear data from UK into ENDF/B format. Secondary energy distribution laws are treated in an approximated way. Care has been taken in order to avoid any machine dependent feature in the program. (auth)

10782 (UCRL–74277) CALCULATIONAL MODELS FOR LLL PULSED SPHERES. Plechaty, E. F. (California Univ., Livermore. Lawrence Livermore Lab.). Oct 1972. 22p. (CONF-721117–1). Dep. NTIS.

From Cross Section Evaluation Working Group meeting; Upton, NY (8 Nov 1972).

Calculational models for LLL pulsed spheres are presented, together with a discussion of the effects of simplifications. Data relevant to detector response functions, pertinent geometric configurations and all other information required to calculate time spectra of detected neutrons are included. (auth)

10783 INVESTIGATIONS OF THE NEUTRON ENERGY SPECTRUM IN THE LOWER eV REGION BY A SCATTER PEEL-OFF METHOD. Bayer, A. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Energy; 26: No. 11, 549-59(Nov 1972).

A newly developed "scatter peel-off method" is described for investigations of the neutron energy spectrum in the lower eV region. Measurements are reported. This out-of-pile method utilizes the energy loss-scattering angle relation which governs the elastic neutron-hydrogen scattering. The differentiation of the angle-dependent reaction rate measured behind the scatterer by a cadmium covered He^3-detector yields the structure of the neutron spectrum from the cut-off energy of cadmium near 0.6 eV up to an energy of about 50 eV, which is the limit set by the resolution of the device. Theoretical fundamentals are explained, the device is described and related problems are discussed. The first measurements performed on a 1/E-spectrum, which was modified by known absorbers, showed the usefulness of this method. Further measurements performed on a hard spectrum were compared with measurements of resonance foils. (auth)

10784 SLOWING DOWN TIME OF NEUTRONS IN GRAPHITE. Hanna, N. N.; Harris, M. J. (Univ. of Manchester, Eng.). J. Nucl. Energy; 26: No. 11, 561-7(Nov 1972).

Using a pulsed source of 14 MeV neutrons, the slowing down time to an energy of 0.555 eV was measured, by a cadmium transmission technique, in 6 blocks of graphite in the buckling range 2.990 to 22.186×10^{-3} cm^{-2}. The results indicated that diffusion time and diffusion cooling effects were small. A value of 37 ± 2 μsec was obtained for the slowing down time in an infinite block of graphite of density 1.685 g cm^{-3}. The result is compared with theory and indicates the marginal superiority of the crystalline model for describing slowing down to these energies in graphite. (auth)

10785 REMOVAL CROSS SECTION OF IRON AT 14.1 MeV. Cooper, P. N.; Kabir, S. M. (Aston Univ., Birmingham, Eng.). J. Nucl. Energy; 26: No. 11, 569-71(Nov 1972).

The attenuation in iron of accelerator produced neutrons of energy 14.1 MeV was investigated both in slab and cylindrical geometry. Neutrons were detected by counting the induced activity in copper from the $^{63}Cu(n2n)^{62}Cu$ threshold reaction. In both geometries the neutron distribution was found to vary inversely with (distance)^2 from the target together with an exponential attenuation in the iron. This attentuation yielded a removal cross section having a value of 1.42 ± 0.015 barn at 14.1 MeV, in good agreement with predictions by Avery. (auth)

10786 APPLICATION OF SPACE-DEPENDENT MULTIGROUP THEORY TO THE ANALYSIS OF NEUTRON SLOWING DOWN TIME EXPERIMENTS. 2. GRAPHITE AND LEAD MODERATORS. Beynon, T. D. (Univ. of Birmingham, Eng.). J. Phys., D (London): 5: No. 9, 1521-30(Sep 1972).

Detailed numerical studies are made of recent measurements by Sumita and Takahashi (Proc. Symp. on Neutron Thermalization and Reactor Spectra Vol. II, I.A.E.A. Vienna p. 461 (1968)) of average and most probable slowing-down times to thermal energies in graphite. Good agreement is obtained between computed and measured values at 5.2, 4.91, 1.46, 0.28, 0.20 and 0.11 eV. Similar studies are successfully made of the lead slowing-down-time spectrometer for a variety of detectors covering the energy range 1 to 3 keV. Estimates are made of the effects of data uncertainties on the theoretical values. (auth)

10787 QUASI-ELASTIC SCATTERING OF NEUTRONS FROM C_6H_6 AND C_6D_6. Winfield, D. J.; Ross, D. K. (Univ. of Birmingham, Eng.). Mol. Phys.; 24: No. 4, 753-72(Oct 1972).

The quasi-elastic scattering of cold neutrons from liquid and solid C_6H_6 and C_6D_6 was measured at temperatures between 260 and 325°K for incident wavelengths between 4.07 Å and 7.05 Å and for angles of scatter between 20° and 90° by means of a chopper time-of-flight apparatus. From the results, the total quasi-elastic intensity and the width of the corresponding broadening, presumed Lorentzian, were extracted. The broadening of the incoherent component in the scattering is discussed in terms of various models designed to combine the effects of center of mass and jump rotational diffusion. All the models could be fitted to the results, using a root-mean-square jump length approximately equal to the nearest H–H distance. Using the "effective mass approximation" the model can be extended to cover the coherent contributions to the scattering. When this is done, it is found that the fit is rather better if the rotational jumps are assumed not to contribute to the coherent broadening. The mean interval between jumps at 293 K was found to be $2.2 \pm 0.5 \times 10^{-12}$ s with an activation energy of 2.1 ± 0.6 kcal/mole, in good agreement with 1.4×10^{-12} s and 1.8 kcal/mole obtained by NMR techniques. (auth)

10788 ANGULAR DISTRIBUTION OF THERMAL NEUTRONS AT THE SURFACES OF CADMIUM AND COPPER CYLINDERS. Doutriaux, Daniel Gerard. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa.

Thesis.

In order to make predictions about the power and the fuel burn-up, it is important to know in detail the neutron distribution in a nuclear reactor. Theoretical methods for calculating spatial

and spectral distributions of neutrons have been developed by several researchers. The experimental method for determination of the neutron spectrum is fairly well known. Although some work has been done to measure the angular distribution of low-energy neutrons leaking from various slabs, very little work has been done to measure the angular distribution of neutrons at the interface between an absorbing rod and a moderator (light or heavy water). In the present study, measurements of the angular distribution of thermal neutrons have been carried out at the surface of black and grey cylinders. Absorbers, 1.0 and 1.5 inch diameter, were positioned with 0.66-0.41 inch annular gap in a 2.5 inch O.D. aluminum thimble in the central thermal column of the AECL's critical reactor ZEEP. Angular distribution was measured with a directionally sensitive detector, which consisted of a copper wire centered in a cadmium cylinder, having a slot along one generatrix. It gave an integral measurement in the axial plane and a differential response in the transverse plane, so that the problem could be studied in two dimensions. The distribution of thermal neutrons at the absorber-air interface was calculated by the "optical-path method," which considers at any point of observation M, the direct contribution to the neutron angular flux $\Psi_M(r,\Omega)$ from neutron sources in the surrounding medium along a line passing through M and having a direction Ω. Comparisons of the experimental data with the theoretical predictions were based upon a radial flux distribution calculated with the THERMOS code or measured. A reasonable agreement between the measured and the predicted values was obtained. By using this new technique, it was shown that the angular flux distribution of neutrons coming from the moderator may be predicted by diffusion theory (P_1-Approximation), but the scalar flux at the point of observation must be calculated by the transport theory. A least-squares fitting of points calculated by the "optical-path method" also has shown that the angular flux distribution of neutrons coming from the absorber follows a P_3-Approximation. These results show the degree of anisotropy of the neutron flux distribution at the point of interest and hence one can determine how many terms to carry in the Legendre polynomial expansion of the angular flux $\Psi(r,\Omega)$, while solving the Boltzmann equation in neutron transport theory. (Diss. Abstr. Int., B)

10789 COHERENT NEUTRON SCATTERING BY LIGHT WATER (H_2O) AND A LIGHT-HEAVY WATER MIXTURE (64 PERCENT H_2O/36 PERCENT D_2O). Powles, J. G.; Dore, J. C.; Page, D. I. (Univ. of Kent, Canterbury, Eng.). Mol. Phys.; 24: No. 5, 1025-37(Nov 1972).

Measurements were made, with high statistical accuracy, of the differential-scattering cross section for 1.06-Å neutrons by light water and a special mixture of light and heavy water at 22°C. For light water, the structure in the scattering pattern is attributed mainly to coherent scattering; a structure factor was obtained over a limited range of momentum transfer. For the chosen mixture, the protons and deuterons give no contribution to the coherent scattering and a structure factor was obtained which corresponds very well to the oxygen-nucleus structure factor obtained from x-ray data. The results show the desirability of extending these high-accuracy measurements using isotopic substitution methods as a means of obtaining the three partial structure factors for water. The method of isotopic mixtures is applicable to a wide range of proton-containing liquids. (auth)

10790 NEUTRONS AND DYNAMICS OF MATTER. Larsson, K.-E. (Chalmers Tekniska Hoegskola, Goteborg). Sv. Naturvetensk.; 25: 9-34(1972). (In Swedish).

A review is given of neutron interactions with matter. A detailed discussion of the principles of dynamics of matter is given in the first part of the paper. The use of neutrons to study the dynamical events on the atomic scale is described and the fundamental results of neutron scattering studies carried out over a period of 15 years are reviewed in the second part of the paper. (auth)

10791 INVESTIGATION OF NONEXPONENTIAL DECAY OF NEUTRON DISTRIBUTIONS IN GRAPHITE. McFarlane, H. F. (California Inst. of Tech., Pasadena). Nucl. Sci. Eng.; 49: No. 4, 438-49(Dec 1972).

Integral measurements were made of pulsed neutron distributions in graphite stacks ranging in buckling from 0.0051 to 0.018 cm^{-2}, and the results were compared to a modeled theoretical computation. Based on these measurements, a critical buckling of 0.0085 cm^{-2} was defined above which the decay of the neutron pulse is non-exponential. Non-exponential decay was observed in six graphite stacks which exceeded the critical buckling, while in three larger assemblies the decay was exponential over a significant part of the total measuring interval. From measurement of the time-dependent spatial distribution in four graphite assemblies, the effective decay constants of the two lowest order spatial modes were computed as well as the time-dependent effective wave number of the distributions. The failure of the neutron distribution to establish either an exponential decay or an asymptotic spatial distribution was interpreted in terms of recent theoretical work in this area. (auth)

10792 MODIFIED VARIATIONAL METHOD FOR THE PULSED-NEUTRON PROBLEM. Ahmed, F.; Rangaswamy, L.; Kothari, L. S. (Univ. of Delhi). Transp. Theory Statist. Phys.; 2: No. 3, 197-209(1972).

A variational method specially suited to neutron problems in small assemblies of coherent scatterers is described. The trial function used is a linear combination of a Maxwellian and exact solutions of the eigenvalue equation for two chosen values of buckling. This method accounts rather accurately for the sharp variations in the asymptotic neutron-energy spectrum (which arise because of discontinuities in the values of total scattering and transport cross sections) and also gives very accurate values for the fundamental mode-decay constant. As examples we have considered the decay of a neutron pulse in beryllium, beryllium oxide, and ice. (auth)

10793 EXISTENCE AND UNIQUENESS OF THE SOLUTION TO THE CRITICAL PROBLEM IN THE MULTIGROUP NEUTRON-TRANSPORT THEORY. Borysiewicz, M.; Mika, J. (Inst. of Nuclear Research, Swierk, Poland). Transp. Theory Statist. Phys.; 2: No. 3, 243-70(1972).

The critical problem for a finite reactor system is formulated in the framework of the multigroup approximation. Under the condition that the system has spectrum-regenerated properties, it is proved that the critical problem to the multigroup transport equation has a unique solution. This solution is nonnegative and essentially bounded everywhere. (auth)

10794 TRAVELING-MODE SOLUTION OF TRANSPORT-THEORY PROBLEMS BY INSPECTION. Aronson, R. (New York Univ., Bronx, N. Y.). Contract AT(30-1)-4090. Transp. Theory Statist. Phys.; 2: No. 3, 181-96(1972).

The differential neutron flux in slab geometry can be represented as a linear combination of traveling eigenmodes that propagate with exponential decay as functions of distance. The operators that serve to analyze the flux into mode amplitudes and to synthesize the flux from the mode amplitudes are determined. The particular analyzers and synthesizers it is appropriate to use in any given situation depend on the boundary conditions. These operators have an interpretation independent of any particular problem. The fluxes of interest can be written down almost by inspection in terms of these operators. (auth)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 10435, 10526, and 10977.

10795 (CONF-720701-(Absts.)) CONFERENCE ON NUCLEAR STRUCTURE STUDY WITH NEUTRONS, JULY 31-AUGUST 5, 1972, BUDAPEST. Contributions. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1972. 271p.

One hundred twenty-eight of the papers included are listed by title in NSA. The remaining papers were too brief for inclusion in NSA. (J.W.R.)

For abstracts of individual papers see: 9267, 9636–9639, 9683, 10779, 10780, 10796–10799, 10812–10815, 10833–10838, 10857–10863, 10870–10875, 10885–10906, 10920–10929, 10942–10950, 10959–10970, and 10982–11021.

10796 (CONF-720701-(Absts.), pp 44-5) STUDY OF THE $^2H(p,pn)$ AND $^2H(d,dpn)$ REACTIONS AT LOW BOMBARDING ENERGIES. Phillips, G. C. (Rice Univ., Houston, Tex.); Duck, I. M.; Valkovic, V. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10797 (CONF-720701-(Absts.), pp 46-7) POLARIZATION OF NEUTRONS FROM $^2H(d,n)^3He$ IN THE DEUTERON ENERGY RANGE 0.2 TO 4 MeV. Galloway, R. B.; Davie, H.; Maayouf, R. M. A.; Vass, D. G. (Univ. of Edinburgh). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10798 (CONF-720701-(Absts.), pp 124-5) NEW MEASUREMENT OF THE N + T DIFFERENTIAL ELASTIC CROSS-SECTION AT 14 MeV. Desreumaux, S.; Chisholm, A.; Perrin, P.; Bouchez, R. (CEN, Grenoble, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10799 (CONF-720701-(Absts.), pp 174-5) POLARIZATION MEASUREMENTS IN THE ELASTIC SCATTERING OF 35 MeV NEUTRONS BY DEUTERIUM. Zamudio, J.; Bonner, B. E.; Brady, F. P.; Jungerman, J. A.; Wang, J. (Univ. of California, Davis). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10800 (JINR-P1-6692) STUDY OF THE ELASTIC $\pi^{\pm}$-MESON SCATTERING BY ^{3}He AND ^{4}He AT 100 MeV. Garfan'ini, R.; Georgecku, K.; Kulyukin, M. M.; Lyashenko, V. I.; Mikhul, A.; Nikitinu, F.; Piradzhino, G.; Pontekorvo, D.; Falomkin, I. V.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U.S. Sales Only).

Differential cross sections (angular distributions) of the elastic $\pi^{\pm}$-meson scattering by ^{3}He and ^{4}He at 100 MeV are measured. The phase-shift analysis is performed for π^{4}He. The data on π^{3}He are approximated using the Legendre polynomials. (auth)

10801 REMARKS ON THE CHARGE FORM FACTOR OF ^{4}He AND THE CENTER-OF-MASS MOTION SPURIOSITY. Ciofi Degli Atti, C.; Lantto, L.; Toropainen, P. (Oulu Univ., Finland). Phys. Lett.; 42B: No. 1, 27-30(13 Nov 1972).

It is shown that the various single-particle wave functions used to reproduce the charge form factor of the ^{4}He nucleus contain a large amount of center-of-mass motion spuriosity, so that the good fit to the experimental data obtained with these wave functions is only due to the way the center-of-mass motion coordinate was removed rather than to the characteristics of the model. (auth)

10802 PHASE-SHIFT ANALYSIS OF p-d ELASTIC SCATTERING. Schmelzbach, P. A.; Grueebler, W.; White, R. E.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A197: No. 1, 273-89(1972).

Phase shifts for p-d elastic scattering were extracted from the differential cross sections, proton polarization, vector and tensor analyzing powers of the ^{1}H(d,d)^{1}H scattering between E_d = 6.0 and 11.5 MeV. Good fits to all the experimental data analyzed could be obtained if, in the analysis, all physically expected degrees of freedom such as the splitting of phase shifts, mixing of states of different orbital angular momentum and non-conservation of channel spin were allowed. The angular momenta were restricted to $L \leq 4$. The results are discussed and the influence of splitting and mixing on the observables are investigated. The Wolfenstein parameters of the proton scattering are predicted for the present solution and their insensitivity to changes in the phase shifts and mixing parameters is shown. (auth)

10803 VECTOR AND TENSOR ANALYZING POWERS IN DEUTERON-DEUTERON ELASTIC SCATTERING AT 10 MeV. Meyer, H. O.; Schiemenz, P. (Univ. of Wisconsin, Madison). Nucl. Phys.; A197: No. 1, 259-64(1972).

The angular distributions of the analyzing powers iT_{11}, T_{20}, T_{21} and T_{22} of the elastic scattering of polarized deuterons on deuterons have been measured at a bombarding energy of 10 MeV. The elastically scattered deuterons were identified by observing them in coincidence with the recoil deuterons. All analyzing powers have small but non-zero values. An attempt is made to discuss the results in terms of phase shifts. (auth)

10804 PARITY NON-CONSERVATION IN RADIATIVE THERMAL NEUTRON CAPTURE BY PROTONS. Lobashov, V. M.; Kaminker, D. M.; Kharkevich, G. I.; (and others) (Nuclear Physics Inst., Leningrad). Nucl. Phys.; A197: No. 1, 241-58(1972).

The circular polarization of γ-quanta from the reaction $n + p \rightarrow d + \gamma$ has been measured using a light-water neutron trap in the reactor active zone as a γ-ray source. The trap was shielded from the γ-radiation of the active zone by lead and bismuth screens. The effective source activity was 10^{16} γ-quanta/sec. For the γ-ray circular polarization measurements use was made of a transmission-type polarimeter and of integral current detection with the separation and accumulation of a periodic signal. Zero control experiments were carried out using γ-quanta from the ^{24}Mg and ^{48}Ti(n,γ)^{49}Ti reaction as non-polarized γ-ray sources. The circular polarization of γ-rays from the reaction $n + p \rightarrow d + \gamma$ was found to be $P = -(1.30 \pm 0.45) \times 10^{-6}$. (auth)

10805 PROTON AND DEUTERON-INDUCED DEUTERON BREAK-UP AT 12.5 MeV. Ibarra, E. A. Houston, Tex.; Rice Univ. (1972). 150p. University Microfilms Order No. 72-26,425.

Thesis.

Proton-proton and proton-neutron coincidence spectra from the $p + d \rightarrow p + p + n$ reaction were measured simultaneously for E_p = 12.5 MeV and $\theta_1 = -\theta_2 = \theta$ in the internal $15° \leq \theta \leq 60°$. In addition, proton-neutron coincidences with detectors at the same angles were measured in order to study the angular dependence of n-p final-state interactions. Deuteron-proton and deuteron-neutron coincidence was also measured for the $d + d \rightarrow d + p + n$ reaction at E_d = 12.5 MeV for $\theta_1 = -\theta_2 = \theta$ in the interval $15° \leq \theta \leq 40°$. The measured spectra are discussed in terms of the quasi-free scattering model. The shape of measured spectra and the angular dependence of the peak cross sections are fairly well reproduced by a simple theory. It was found that the ratio of the peak cross section for n-p and p-p quasi-free scattering in the $p + d \rightarrow p + p + n$ reaction varied from 1.3 at $\theta = 15°$ to 4.3 at $\theta = 42.5°$. The ratio of the peak cross section for d-n and d-p quasi-free scattering in the $d + d \rightarrow d + p + n$ reaction was found to be constant and close to one. The variation of σ_{pn}/σ_{pp} peak ratio in the $p + d \rightarrow p + p + n$ reaction can be attributed to the influence of n-p and p-p final-state interactions. (Diss. Abstr. Int., B)

10806 ELASTIC SCATTERING AND POLARIZATION OF FAST NEUTRONS BY LIQUID DEUTERIUM AND TRITIUM. Seagrave, J. D.; Hopkins, J. C.; Dixon, D. R.; (and others) (Los Alamos Scientific Lab., NM). Ann. Phys. (N. Y.); 74: No. 1, 250-99(Nov 1972).

One-mole samples of all three hydrogen isotopes in liquid form were employed to obtain complete angular distributions of the absolute differential cross sections for n-D scattering at neutron energies of 5.6, 7.0, 8.0, 9.0, 18.55, 20.5, and 23.0 MeV, for n-T scattering at 6.0, 9.0, 18.0, 19.5, 21.0, and 23.0 MeV, and for n-T polarization at 22.1 MeV. Time-of-flight techniques were used with the Mobley beam-compression system at the Los Alamos Scientific Laboratory vertical Van de Graaff accelerator. Neutrons were detected in large liquid scintillators in collimators heavily shielded with copper, tungsten, and polyethylene. Electronic discrimination against gamma rays was applied, and the raw data and preliminary statistical reduction were handled on line by an SDS-930 computer. Comparison is made with the limited amount of neutron cross-section data previously available, with the more extensive recent measurements of the charge-conjugate systems p-D and p-^{3}He, and with various calculations and phase-shift representations. The differences between the deuterium total and integral elastic cross sections are smaller than previous extrapolation of nonelastic cross sections below 14 MeV. (auth)

10807 VECTOR AND TENSOR POLARIZATIONS IN NUCLEON-DEUTERON SCATTERING. II. Sloan, I. H. (Univ. of Maryland, College Park); Aarons, J. C. Nucl. Phys.; A198: No. 2, 321-42(1972).

The nucleon and deuteron polarizations and the differential cross sections in N-d scattering are studied for the case of separable $^{1}S_0$ and $^{3}S_1-^{3}D_1$ potentials, with two different choices of form factors. The first uses Yamaguchi form factors in both the $^{1}S_0$ and $^{3}S_1-^{3}D_1$ case. The second tries to take account of the short-range N-N repulsion by using the unitary pole approximation to the Reid $^{1}S_0$ soft-core potential and the modified Hulthén $^{3}S_1-^{3}D_1$ potential of Brady et al. It is found that the variations of the form factors and of the percentage D state of the deuteron have only a small effect on all of the polarizations. Therefore, the model is completely inadequate for predicting the vector polarizations, but gives at least some of the qualitative features of the second-rank deuteron polarizations and also, of course, of the differential cross sections. A generalization of the scattering equations to the case of N-N interactions of arbitrary rank in any number of coupled or uncoupled N-N partial waves is also given. (auth)

10808 TOTAL NEUTRON CROSS SECTION OF DEUTERIUM BELOW 1000 keV. Stoler, P. (Rensselaer Polytechnic Inst., Troy, NY); Kaushal, N. N.; Green, F.; Harms, E.; Laroze, L. Phys. Rev. Lett.; 29: No. 26, 1745-8(25 Dec 1972).

Total neutron cross sections of deuterium have been measured from less than 1 keV to 1000 keV. A three-body calculation of n-D total scattering cross sections was performed, using separable potentials. The theoretical and experimental results show good agreement. A marked increase in cross section is observed for decreasing energy below 300 keV. The implications of the results are discussed with respect to discrepancies in previously measured n-D scattering lengths. (auth)

10809 GAMMA RAY AND PI-ZERO PRODUCTION FROM HYDROGEN AND COMPLEX NUCLEI BY 320 MeV GAMMA RAYS. Beron, B. L. Stanford, CA; Stanford Univ. (1972). 62p. University Microfilms Order No. 72-30,588.

Thesis.

A study was made of the production of secondary gamma rays during the interaction of hardened bremsstrahlung beams with hydrogen and selected nuclear targets in the range ^{7}Li to ^{208}Pb. The measurements were made at the Stanford Mark III linear electron accelerator for bremsstrahlung end-point energies of 270 and 375 MeV. Cross sections for the production of gamma

rays in the range 20 MeV up to the end-point energy are given for a laboratory angle of 90 degrees. A large NaI(Tl) crystal spectrometer was used to detect the gamma rays and to measure their energies to a precision of 8% (FWHM). Secondary neutrons were rejected by a time-of-flight technique made possible by imposing an appropriate time structure on the accelerated electron beam. The measured spectra are in reasonable agreement with calculations made with known coherent and incoherent pi-zero photoproduction cross sections. The spectrum shapes for the incoherent component agree with a model using a constant nuclear motion of 10 MeV, indicating production principally from surface nucleons. The data are also in agreement with calculations using extrapolations of isovector pi-zero photoproduction amplitudes determined at lower energies. The total cross sections show the well known nuclear surface area dependence. The experiment has proven the practicality of using large NaI(Tl) crystals as a high resolution gamma ray spectrometer in high energy physics experiments. (Diss. Abstr. Int., B)

10810 MAGNETIC MOMENTS OF ^{3}H AND ^{3}He IN THE QUARK MODEL. Ichimura, M.; Hyuga, H.; Brown, G. E. (State Univ. of New York, Stony Brook). Nucl. Phys.; A196: No. 1, 17-33(1972).

The magnetic moments of ^{3}H and ^{3}He were studied by treating the nucleons N and nucleon resonance states N*(1236 MeV) on the same footing. The quark model is used to determine potentials and magnetic-moment operators operating on states consisting of N and/or N*. It is found that strong cancellations take place between effects from wave-function renormalization and cross terms between N and N* states. Hence, even a sizable N* component does not shift the magnetic moments of ^{3}H and ^{3}He from their Schmidt values. Further, the two-N* state in the trinucleon system is taken into account as well as the one-N* state. The two-body exchange magnetic moments coming from the so-called Born term, including the contributions from the transitions between the S-state and the D-state, the S-state and the one-N* state and the S-state and the two-N* state, are evaluated. They are all additive with the same sign. The calculated values of the isoscalar and the isovector parts are $\mu^S_{cal} = 0.42-0.43$ and $\mu^V_{cal} = 2.61-2.67$, which are close to the experimental values $\mu^S_{exp} = 0.426$ and $\mu^V_{exp} = 2.553$. Corrections to the β-decay amplitude are discussed briefly. (auth)

10811 POLARIZATION TRANSFER IN THE ^{2}H(d,p)^{3}H REACTION AT 0°. Duder, J. C.; Stephenson, E. J.; Haeberli, W. (Univ. of Wisconsin, Madison). Nucl. Phys.; A196: No. 1, 107-12(1972).

Measurements have been made of the polarization of protons at 0° from the ^{2}H(d,p)^{3}H reaction at 7.1 and 9.8 MeV using deuteron beams with either vector or tensor polarization. The proton polarization was observed to nearly equal the deuteron vector polarization. (auth)

Nuclear Properties and Reactions, 6 ≤ A ≤ 19

Refer also to abstracts 9696, 10431, 10488, 10526, 10795, 10809, 10852, and 10977.

10812 (CONF-720701-(Absts.), pp 28-9) NEUTRON SPECTROSCOPY BY THE USE OF (d,n) REACTIONS AT TANDEM ENERGIES. Rendic, D. (Inst. Rudjer Boskovic, Zagreb). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10813 (CONF-720701-(Absts.), pp 108-9) ENERGY DISTRIBUTION OF DELAYED NEUTRONS FROM ^{17}N. Shalev, S.; Cuttler, J. M.; Ben Yaakov, G. (Technion, Haifa, Israel). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10814 (CONF-720701-(Absts.), pp 130-1) CROSS-SECTION OF (n,t) REACTIONS WITH 14 MeV NEUTRONS DETERMINED BY DIRECT β-COUNTING OF TRITIUM. Biro, T.; Sudar, S.; Csikai, J. (Kossuth Univ., Debrecen, Hungary). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10815 (CONF-720701-(Absts.), pp 134-5) SCATTERING OF 14.1 MeV NEUTRONS AT BACKWARD ANGLES. Bonazzola, G. C. (Univ., Turin); Bressani, T.; Chiavassa, E.; Naldi, L.; Minetti, B. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10816 (FRNC-TH-276) SPECTROSCOPIC STUDY OF THE ^{16}O NUCLEUS FROM MEASUREMENTS OF THE ELECTROMAGNETIC TRANSITION PROBABILITIES. Brochard, Francois (Strasbourg Univ. (France)). 1972. 101p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The electromagnetic de-excitation of the following levels: 12.53 MeV ($J^\pi = 2^-$, T = 0), 12.79 MeV (0^-, 1), 12.97 MeV (2^-, 1), 13.09 MeV (1^-, 1), 13.26 MeV (3^-, 1), and 13.66 MeV (1^+, 0), towards the 6.13 MeV (3^-, 0); 6.92 MeV (2^+, 0), 7.12 MeV (1^-, 0), and 8.88 MeV (2^-, 0) levels was studied. Information already available about the 9.60 MeV (1^-, 0) level was completed from investigations of transition from the first T = 1 excited states to this level. The value obtained for the branching ratio R = 9.60 MeV → 6.05 MeV/9.60 MeV → 0 is $4.3.10^{-2} \pm 0.4$. The over all results obtained demonstrate that the Zuker et al. shell model gives a good description of the isospin mixing between the T = 0 and T = 1 levels and invalidate the hypothesis of an intense 3t−3p component in these last states and their ^{16}N nucleus analogues. An almost entirely 5t−5p description is concluded for the 9.60 MeV level. This result invalidates the hypothesis of mixing between the 7.12 and 9.60 MeV levels. (France)

10817 (JINR-E4-6606) HIGH-ENERGY NEUTRONS FROM MUON CAPTURE BY COMPLEX NUCLEI. Eramzhyan, R. A.; Salganik, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 18p. Dep. NTIS (U. S. Sales Only).

The neutron channel in muon capture by complex nuclei $\mu^- + (A, Z) \rightarrow (A-1, Z-1) + n + \nu$ is investigated. The calculation is made for the ^{16}O nucleus. The transitions to the $\frac{1}{2}^-$ (g.s.), $\frac{3}{2}^-$ (E = 6.33 MeV), $\frac{1}{2}^+$ and $\frac{5}{2}^+$ (E = 5.3 MeV) levels of ^{15}N are considered. It is shown that the final-state interaction between an outgoing neutron and the residual nucleus changes the monotonic energy dependence of high-energy asymmetry, as predicted in a plane-wave approximation. When the transitions to the definite state of the final nucleus are singled out, one can obtain a detailed information and identify the main features of muon capture with high-energy neutron emission. (auth)

10818 (LA-2234(Rev.)) AN INTEGRAL EXPERIMENT TO MEASURE THE TRITIUM PRODUCTION FROM ^{7}Li BY 14-MeV NEUTRONS IN A LITHIUM DEUTERIDE SPHERE. Wyman, M. E. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 14p. Dep. NTIS.

A sphere of LiD 2 ft in diameter was irradiated by 2×10^{15} 14-MeV neutrons. Samples of ^{7}Li metal were positioned at various radii for the irradiation. An analysis of these samples for tritium led to a determination of the number of tritons produced by 14-MeV neutrons acting on ^{7}Li in a LiD system. (auth)

10819 (LA-4725) EVALUATION OF THE NEUTRON AND GAMMA-RAY PRODUCTION CROSS SECTIONS FOR NITROGEN. Young, P. G.; Foster, D. G. Jr. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 77p. Dep. NTIS.

This report describes a complete evaluation of the neutron cross sections of ^{14}N from 10^{-5} eV to 20 MeV, including photon-production cross sections and energy and angular distributions of secondary neutrons and photons. The recommended data are based mainly on experiment, augmented by calculations from nuclear models where appropriate. The evaluated data are available on magnetic tape in ENDF/B(III) format. (auth)

10820 (LYCEN-7239) STUDY OF THE TRANSFER OF AN α CLUSTER IN (d,^{6}Li) REACTIONS WITH CERTAIN LIGHT NUCLEI. Bedjidian, M. (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

The (d,^{6}Li) reaction with ^{12}C, ^{16}O, ^{19}F and ^{40}Ca was studied at 28 MeV. In addition to the ground state transitions, it was possible to identify transitions to the 4.43 MeV 2^+ state of ^{12}C and the 1.98 MeV state of ^{36}Ar. The shape of the experimental cross sections confirms the direct nature of the interaction. Calculations with a cutting radius demonstrate that the reaction occurs preferentially at the nuclear surface. This fact agrees with the strong absorption of deuterons and lithium observed. These reactions were studied with the assumption of the capture of an α cluster pre-existing in the target nucleus. The transfer of this α cluster was analyzed in the framework of the distorted wave approximation, the cluster being considered as a particle in a given state determined by the conservation of energy and the kinetic moment laws established from the shell model. The zero-range approximation for the d−α interaction appears to be acceptable. The spectroscopic factors were determined relative to that of carbon: the values obtained for the $S_1/S_1(^{12}C)$ ratios confirm the validity of the model used. (France)

10821 EXCITATION FUNCTION FOR THE ^{12}C(d,p$_0$)^{13}C REACTION BETWEEN 400 AND 1350 keV: ANGULAR DISTRIBUTIONS. Huez, M.; Quaglia, L.; Weber, G. (Univ., Liege). Nucl. Instrum. Methods; 105: No. 2, 197-203(1972). (In French).

The excitation function for the $^{12}C(d,p_0)^{13}C$ reaction was measured at $\theta = 150°$ for 400 to 1350 keV deuteron energy. The angular distribution was measured from 80° up to 160°. These measurements were performed to use this reaction for superficial carbon determination by direct observation of the emitted protons. (4 figures, 2 tables) (auth)

10822 STUDY OF ^{17}F ABOVE 19 MeV FROM ^{3}He BOMBARDMENT OF ^{14}N. Mo, T.; Blue, R. A.; Weller, H. R. (Univ. of Florida, Gainesville). Nucl. Phys.; A197: No. 1, 290-304(1972).

Cross sections for the reactions $^{14}N(^{3}He,\gamma)^{17}F$, $^{14}N(\tau,\alpha)^{13}N$ and $^{14}N(^{3}He,^{3}He)^{14}N$ have been measured for bombarding energies from 3.5 to 7.0 MeV. Three strong resonances were observed corresponding to levels in ^{17}F at excitation energies of 19.42, 20.25 and 21.01 MeV. Angular distributions were measured in the vicinity of these resonances for the γ-ray and α-particle channels. Theoretical fits to the excitation functions and angular distributions of the three reactions permit spin and parity assignments of $^{5}/_{2}^{+}$, $^{1}/_{2}^{-}$ and $^{1}/_{2}^{+}$ to the levels at 19.42, 20.25 and 21.01 MeV in ^{17}F, respectively. In addition, the (τ,γ) data show another relatively weak resonance at $E_\tau \approx 5.7$ MeV corresponding to $E_x = 20.53$ MeV in ^{17}F. A tentative assignment of $J^\pi = {}^{3}/_{2}^{-}$ for this state is consistent with the experimental results. A comparison of the present results for $^{14}N + \tau$ with previous investigations of the same reaction channels for $^{14}C + \tau$ suggests a possible correlation between the observed states in ^{17}F with a similar group in ^{17}O. The ^{17}O states appear at an excitation energy which is shifted upward by approximately 2 MeV with respect to the ^{17}F states. (auth)

10823 PHOTODEUTERONS FROM ^{12}C. Skopik, D. M.; Shin, Y. M.; Horniachek, J. W.; Kundu, S. K. (Saskatchewan Accelerator Lab., Saskatoon). Nucl. Phys.; A197: No. 1, 185-92(1972).

Cross sections and angular distributions for the reaction $^{12}C(\gamma,d)^{10}B$ have been measured using solid-state detectors mounted in the focal plane of a magnetic spectrometer. The angular distribution of the deuterons restricted to ground or near ground-state transitions is consistent with an E2 reaction; however at deuteron energies not so restricted the reaction appears to be different from pure E2. Deuteron emission was also studied as a function of incident electron energy. A comparison with simple models is made and an estimate of the 2p-2h contribution to the ground state of ^{12}C is presented. (auth)

10824 NUCLEAR-COULOMB INTERFERENCE IN THE SCATTERING OF POSITIVE PIONS BY CARBON. Scott, M. L. Houston, Tex.; Rice Univ. (1972). 146p. University Microfilms Order No. 72-26,471.

Thesis.

The small-angle scattering cross section of positive pions from ^{12}C has been measured from 3° to 9° laboratory scattering angle at pion kinetic energies of 115, 167, and 242 MeV. In this angular region the nuclear-Coulomb interference is most pronounced, and the known Coulomb scattering allows one to extract the magnitude and phase of the forward nuclear scattering amplitude. Both the Kisslinger optical model, using the parameters determined from π^--^{12}C large angle scattering data, and the Glauber model differ qualitatively from the π^+-^{12}C data at the (3/2,3/2) resonance energy. A phenomenological exponential model was used to parameterize the nuclear amplitudes. Since the π^+-^{12}C total cross sections have not been measured across the (3/2,3/2) resonance, they were allowed to vary in fitting the nuclear amplitudes. At 115 MeV, the π^+-^{12}C scattering data can be described if a π^+ total cross section 10% lower than that measured for π^--^{12}C is assumed, or if a strong variation of the phase of the π^+-^{12}C forward scattering amplitude is assumed. The magnitude and phase of the forward nuclear scattering amplitude should provide a check on forward dispersion relations as well as nuclear models. The development of thin multiwire proportional counters and the associated electronics at Rice University has made possible not only the measurement of the small-angle scattering, but also the measurement of the beam momentum, momentum spread, and beam purity utilizing the $\pi \rightarrow \mu + \nu$ decay distribution. (Diss. Abstr. Int., B)

10825 THEORETICAL AND EXPERIMENTAL STUDY OF THE PRODUCTION OF LIGHT FAST NUCLEI IN HIGH ENERGY PROTON-NUCLEUS INTERACTIONS. Alard, J. P.; Avan, L.; Avan, M.; (and others) (Univ., Clermont-Ferrand, France). J. Phys. (Paris); 33: No. 5, 477-83(May 1972). (In French).

A description is given of an experiment in which ^{1}H, ^{2}H, ^{3}H, ^{3}He, and ^{4}He are produced by interactions between protons and ^{12}C, ^{27}Al and ^{197}Au nuclei. Measurements were made at 30 deg, 45 deg, 75 deg and 105 deg. A thermodynamic theory which permits an interpretation of the experimental results is also given. (auth)

10826 SPECTROSCOPIC INFORMATION FROM $^{10,11}B(d,n\gamma)$ ANGULAR CORRELATION MEASUREMENTS AT 0^0. Thornton, G.; Joy, T.; Calvert, J. M. (Univ. of Manchester, Eng.). Nucl. Phys.; A198: No. 2, 397-416(1972).

The n-γ angular correlations and excitation functions for the $^{10}B(d,n\gamma)^{11}C(6.48)$, $^{11}B(d,n\gamma)^{12}C(15.11)$, and $^{11}B(d,n\gamma)^{12}C(4.43)$ reactions were measured with the neutron detector at 0° for deuteron energies from 4.0 to 4.8 MeV. The results for the first two reactions were found to be consistent with a mainly direct mode, in agreement with previous work. The axially symmetric geometry was exploited to obtain the reduced width amplitude ratio for stripping with $j = {}^{3}/_{2}$ and $^{1}/_{2}$ for the $l = 1$ transfers, information which it is difficult to obtain experimentally by any means where j-mixing occurs. The results were in good agreement with the intermediate-coupling-shell-model predictions of Cohen and Kurath. On the other hand, clear experimental evidence was obtained that the $^{11}B(d,n\gamma)$ $^{12}C(4.43)$ reaction has a significant nondirect component, and, in this case, a spectroscopic interpretation is open to serious doubt. (13 figures, 10 tables). (auth)

10827 STUDY OF ^{15}N BY MEANS OF THE $^{11}B(\alpha,\alpha)^{11}B$ REACTION. Ott, W. R.; Weller, H. R. (Univ. of Florida, Gainesville). Nucl. Phys.; A198: No. 2, 505-14(1972).

The $^{11}B(\alpha,\alpha)^{11}B$ cross section was measured as a function of energy and angle for bombarding energies from 4 to 8 MeV. Many resonances were observed. The data from 4 to 5 MeV were fitted using an R-matrix formalism with background phase shifts evolved from an optical-model potential. The three levels in ^{15}N resulting from this analysis fit into the APCETS scheme for ^{15}N. (5 figures, 2 tables). (auth)

10828 ELASTIC SCATTERING OF ^{16}O ON ^{18}O INCLUDING BACKWARD ANGLES. Gelbke, C. K. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Bock, R.; Braun-Munzinger, P.; (and others). Phys. Rev. Lett.; 29: No. 25, 1683-5(18 Dec 1972).

The elastic scattering of ^{16}O on ^{18}O has been measured for incident beam energies of $E_{lab} = 24$, 28, and 32 MeV at center-of-mass angles up to 150°. The angular distributions exhibit pronounced oscillations at backward angles which may be interpreted as due to the occurrence of an elastic transfer. (auth)

10829 ACTIVATION CROSS SECTIONS FOR THE REACTIONS $^{18}O(p,n)^{18}F$ AND $^{47,48}Ti(p,n)^{47,48}V$ FROM THRESHOLD TO 18 MeV. Mazitov, B. S.; Muminov, V. A.; Mukhamedov, S. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 5, 21-3(1971). (In Russian).

Excitation functions for the reactions $^{18}O(p,n)^{18}F$ and $^{47,48}Ti(p,n)$ $^{47,48}V$ were examined for possible use in the activation analysis of O and Ti. Stacks of Ti, plastic, and Al foils were assembled into a target holder for use with a cyclotron beam of protons. The error in the ^{18}O activation measurements was estimated to be ~15%; the error in the activation of $^{47,47}Ti$ was somewhat less. (K.S.W.)

10830 STUDY OF THE $^{16}O(^{6}Li,t)^{19}Ne$ REACTION. Panagiotou, A. D.; Gove, H. E. (Univ. of Rochester, NY). Nucl. Phys.; A196: No. 1, 145-55(1972).

The reaction $^{16}O(^{6}Li,t)^{19}Ne$ has been employed in the study of ^{19}Ne with 35 and 36 MeV ^{6}Li ions. Triton spectra were obtained covering an excitation energy in ^{19}Ne up to 10 MeV. Some new strongly excited states were found. Angular distributions were obtained between 6° and 39°, in 3° steps. On the basis of the angular distributions and cross sections the following spin and parity assignments were made: $^{13}/_{2}^{+}$, 4.61 MeV; $^{7}/_{2}^{+}$, 5.41 MeV; $(^{5}/_{2}^{-},{}^{7}/_{2}^{-})$, 6.27 MeV, and $(^{9}/_{2}^{-},{}^{11}/_{2}^{-})$, 6.83 MeV. A comparison with the mirror nucleus ^{19}F is made. (auth)

10831 STUDY OF THE (d,n) AND (d,p) REACTIONS ON ^{15}N. Bohne, W.; Bommer, J.;Fuchs, H.; (and others) (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A196: No. 1, 41-57(1972).

Angular distributions of the reactions (d,d_0), (d,p), and (d,n) on ^{15}N were measured at deuteron energies of 5, 5.5, and 6 MeV. Excitation functions were obtained for the reactions (d,d_0) and (d,p) from 4.25 MeV to 6.25 MeV deuteron energy. The experimental data were analyzed with DWBA and Hauser-Feshbach calculations to yield spectroscopic factors. These are compared with results of previous experiments and shell-model calculations. The $p^{-1}d_{5/2}$ configuration is strongly mixed with the states of the $p^{-1}(d_{5/2},s_{1/2})$ configurations; its inclusion therefore is necessary for a correct theoretical description of low-lying T = 0 states in ^{16}O with negative parity. The experimental strengths of the $1d_{5/2}$ and $2s_{1/2}$ transitions to the lowest T = 1 states in ^{16}O and ^{16}N exhaust only about 60% of the total one-particle strength in contrast to existing nuclear structure calculations of A = 16 nuclei. (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 9696, 10371, 10809, and 10825.

10832 (BNL-tr-511) INVESTIGATION OF THE RADIOACTIVE PROPERTIES OF NEON ISOTOPES WITH USE OF THE U-300 CYCLOTRON. Kabachenko, A. P.; Kuznetsov, I. V.; Sivek-Nil'chenska, K.; Skakun, E. A.; Tarantin, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P2-6537. 6p. Dep. NTIS.

Neutron-rich neon isotopes were produced in the bombardment of a tantalum target with a ^{22}Ne beam at approximately 180 MeV. The products were separated with an electromagnetic mass separator. The β activities of nuclides with mass numbers A = 23 to 26 were analyzed. The known β emitters ^{23}Ne, ^{24}Ne, ^{24}Na, and ^{25}Na were identified. A short-lived A = 25 activity was identified as ^{25}Ne and the half-life and β-endpoint energy were measured. In addition, preliminary measurements on the ^{26}Ne half-life were made. (J.W.R.)

10833 (CONF-720701-(Absts.), pp 14-15) STUDY OF THE ^{29}Si(d,n)^{30}P REACTION AT E_d = 4 MeV. Usureau, J.; Ardouin, D.; Tamisier, R.; Rosier, L. H.; Avignon, P. (Institut de Physique, Nantes, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10834 (CONF-720701-(Absts.), pp 150-1) INELASTIC NEUTRON SCATTERING BY ^{27}Al, ^{31}P, ^{32}S, AND ^{56}Fe IN THE ENERGY RANGE 0.8 TO 9.0 MeV. Kellie, J. D.; Islam, M. N.; Crawford, G. I. (Univ. of Glasgow). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10835 (CONF-720701-(Absts.), pp 204-5) CHANNEL DEPENDENT LEVEL WIDTHS AND CORRELATED INTERMEDIATE STRUCTURE IN THE γ-RAY PRODUCTION CROSS SECTIONS OF Al AND Fe. Voss, F.; Cierjacks, S. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10836 (CONF-720701-(Absts.), pp 232-3) RADIATIVE CAPTURE OF ENERGETIC NEUTRONS IN SILICON AND SULPHUR. Nilsson, L. (Tandem Accelerator Lab., Uppsala); Lindholm, A.; Bergqvist, I.; Lundberg, B. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10837 (CONF-720701-(Absts.), pp 236-7) INVESTIGATION OF THE REACTION ^{37}Cl(n,γ)^{38}Cl. Spits, A.M.J. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10838 (CONF-720701-(Absts.), pp 258-9) SEARCH FOR SYSTEMATICS IN FAST NEUTRON RADIATIVE CAPTURE. Holub, E. (Inst. Rudjer Boskovic, Zagreb); Caplar, R.; Kulisic, P.; Cindro, N.; Vuletin, J. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10839 (FRNC-TH-283) EXPERIMENTAL ASPECTS OF THE SPALLATION OF MEDIUM MASS NUCLEI INDUCED BY 300 AND 600-MeV PROTONS. Sauvageon, H. (Bordeaux Univ. (France)). 1972. 91p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The production of ^{24}Na, ^{42}K, ^{43}K, ^{44}Sc(met), ^{46}Sc, and ^{47}Sc in aluminum, scandium, titanium, vanadium, iron, cobalt and copper targets by bombardment with 150, 300, and 600 MeV protons was studied. The different radionuclides were detected by the intermediate of their β and γ radiation emissions; their production cross sections and recoil properties were determined. The mathematical formalism of the thick recoil theory based on the vectorial model of Sugarman (this theory itself being derived from a two-stage mechanism) was adapted to treat spallation. It was shown that the energy required to excite the residual nuclei increases quasi-linearly with the number of nucleons in the cascade and increases with the incident energy. Results on the cross sections and data concerning the recoil enables the spallation reactions to be classified according to the mass difference, ΔA, between the target and the product observed. The classical characteristics of the spallation are verified for the case when $\Delta A \geq 6$ or 7; when $\Delta A \leq 5$, the cross sections do not present the same properties and the excitation energies per nucleon emitted are much greater than for larger ΔA values. (France)

10840 (JINR-E6-6664) BETA DECAY OF ^{22}F. Guratzsch, H.; Kabachenko, A. P.; Kuznetsov, I. V.; Siwek-Wilczynska, K.; Tarantin, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 11p. Dep. NTIS (U. S. Sales Only).

The decay of ^{22}F was investigated by making use of a mass separator on-line with a heavy ion cyclotron. The maximum beta energy was determined to be 5.5 ± 0.1 MeV contrary to the presently known value of 11.2 ± 0.6 MeV. The half-life value of 4.2 ± 0.1 sec was measured. A decay scheme of ^{22}F is proposed. (auth)

10841 (KHFTI-70-79) STUDY OF ISOBAR-ANALOGOUS RESONANCES IN THE REACTION ^{34}S(p,γ)^{35}Cl. Kopanets, E. G.; Migalenya, V. Ya.; L'vov, A. N.; Koval', A. A.; Kostin, B. Ya.; Tsytko, C. P. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 47p. (In Russian). Dep. NTIS (U.S. Sales Only).

The reaction ^{34}S(p,γ)^{35}Cl was investigated with accelerated protons having from 0.7 to 3.0 MeV energy, and a Ta support holding the ^{34}S atoms. The excitation function was measured and 154 resonances were noted as excited states of ^{35}Cl. Reaction yields were computed for a number of these resonances, and gamma ray spectra were obtained with a Ge(Li) spectrometer. Angular correlations of gamma rays relative to the direction of the incident protons were measured with a NaI(Tl) detector and a Ge(Li) spectrometer. (K.S.W.)

10842 (OU-LNS-72-3) PRECISION LIFETIMES OF POSITRON EMITTERS, ^{25}Al, ^{29}P, ^{33}Cl, AND ^{41}Sc, AND FT VALUES OF MIRROR β DECAYS. Tanihata, I.; Minamisono, T.; Mizobuchi, A.; Sugimoto, K. (Osaka Univ. (Japan). Lab. of Nuclear Studies). [nd]. 20p. Dep. NTIS (U. S. Sales Only).

Precision lifetime measurements of positron emitters have been made, in which each object activity was produced at a resonance energy of the proton-capture reaction; thus the foreign activity contamination was minimized. The half-lives of ^{25}Al, ^{29}P, ^{33}Cl, and ^{41}Sc are (7.177 ± 0.023)s, (4.149 ± 0.005)s, (2.513 ± 0.004)s, and (0.591 ± 0.005)s, respectively. The ft values of mirror β decays for 11 ≤ A ≤ 41, which were calculated by using a refined wave function of electron and the recent data, are presented. (auth)

10843 ELASTIC SCATTERING OF 27.5-MeV ALPHA PARTICLES ON ^{27}Al, ^{28}Si, ^{32}S, Ti, AND ^{59}Co NUCLEI AND THE r_0 DISCRETE AMBIGUITY OF THE OPTICAL POTENTIAL. Bobrowska, A.; Budzanowski, A.; Grotowski, K.; (and others) (Jagellonian Univ., Krakow). Acta Phys. Pol., B3: No. 5, 533-49(1972).

Angular distributions for elastic scattering of alpha particles on ^{27}Al, ^{28}Si, ^{32}S, Ti and ^{59}Co nuclei have been measured in the angular range from about 20° to 179° (LAB). The experimental data were fitted with the optical model in full angular range. Many sets of four-parameter potentials, describing the elastic scattering, were found with the depths of the real part ranging from 40 to 450 MeV. A new discrete ambiguity in the optical model, namely in r_0, was observed. (auth)

10844 STUDY OF ENERGY LEVELS OF ^{29}Si VIA DEUTERON STRIPPING. El-Bedewi, F.; Shalaby, M. (Ain Shams Univ., Cairo). J. Phys., A (London); 5: No. 11, 1624-38(Nov 1972).

The ^{28}Si(d,p)^{29}Si reaction has been studied at E_d = 10 MeV with a multigap magnetic spectrograph which can record 24 spectra at angles ranging from 5° to 175°. Eighty-two proton groups have been identified as belonging to the ^{28}Si(d,p) reaction covering excitation energies in ^{29}Si up to 9.676 MeV. Angular distribution measurements on 61 proton groups corresponding to levels up to 9.154 MeV have been carried out and those exhibiting stripping patterns have been analyzed. Spectroscopic factors for bound states have been derived using the finite range DWBA method with nonlocal correction FRNL. (auth)

10845 LIFETIMES OF THE $^3/_2^+$, 975 keV LEVEL IN ^{25}Mg AND THE $^3/_2^+$ 945 keV LEVEL IN ^{25}Al. Alexander, T. K.; Haeusser, O.; McDonald, A. B.; Ewan, G. T. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 50: No. 18, 2198-2205(15 Sep 1972).

The $^3/_2^+$, 975 keV level in ^{25}Mg and the 945 keV level in ^{25}Al were populated in the ^{2}H(^{24}Mg,pγ)^{25}Mg and ^{2}H(^{24}Mg,nγ)^{25}Al reactions respectively and their mean lifetimes for gamma-ray decay were measured by the recoil-distance method. The mean lifetime of the 975 keV level in ^{25}Mg is 14.6 ± 1.5 ps and that of the 945 keV level in ^{25}Al is 6.2 ± 1.6 ps. Using previously measured branching and mixing ratios, the absolute M1 and E2 transition probabilities were obtained and are compared with predictions of the unified model. (auth)

10846 REACTION ^{20}Ne(^{3}He,n)^{22}Mg AT ^{3}He ENERGIES BELOW 6 MeV. Benenson, R. E. (State Univ., of New York, Albany); Taylor, I. J.; Bernard, D. L; Wolter, H. H.; Tamura, T. Nucl. Phys.; A197: No. 1, 305-14(1972).

The ^{20}Ne(^{3}He,n)^{22}Mg reaction has been studied with particular emphasis on some unusual angular distributions observed at bombarding energies between 4 and 6 MeV. A satisfactory explanation of the ground state group differential cross sections is

given by assuming interference between direct interaction and compound-nucleus formation. The ^{22}Mg half-life was measured to be 3.97 ± 0.09 s, and an excitation curve for the ^{22}Mg(β^+) activity was obtained. (auth)

10847 COUPLED-CHANNELS ANALYSIS OF DEUTERON SCATTERING FROM ^{30}Si AT E_d = 10 MeV. Berg, M. (Univ., Erlangen, Ger.); Hofmann, A.; Thomas, K.; Rebel, H.; Schweimer, G. W. Phys. Lett.; 42B: No. 2, 211-12(27 Nov 1972).

Elastic and inelastic differential cross sections for 10 MeV deuteron scattering on ^{30}Si have been analyzed in terms of a symmetric rotator model in the framework of the coupled-channel method. Sign and value of the β_2-deformation are extracted and indicate prolate shape for ^{30}Si. (auth)

10848 STUDY OF RESONANCES IN THE ^{31}P(p,γ)^{32}S REACTION IN THE 1100 TO 1600 keV ENERGY RANGE. Leccia, F.; Aleonard, M. M.; Castera, D.; Hubert, P.; Mennrath, P. (Bordeaux Univ., Gradignan, France). J. Phys. (Paris); 33: No. 5, 451-5(May 1972). (In French).

Twelve resonances were observed in the 1100- to 1600-keV energy range for the ^{31}P(p,γ)^{32}S reaction, five of them being observed for the first time. The strengths of these resonances and the γ decay of the resonance levels were determined together with the energies and branching ratios of the bound levels of ^{32}S. (France)

10849 ANALYSIS OF α-PARTICLE INELASTIC SCATTERING USING HARTREE–FOCK DENSITIES. Mackintosh, R. S. (Australian National Univ., Canberra). Nucl. Phys.; A198: No. 2, 343-52(1972).

Differential cross sections for the elastic and inelastic scattering of α particles by ^{20}Ne and ^{24}Mg were calculated using HF wave functions that had previously been used for (p,p′) calculations. Projected wave functions were not used but consistency between the elastic and inelastic form factors was required. The result is that, although the HF solutions are unable to fit the data, the discrepancy is significantly less than that found in (p,p′) calculations. (4 figures). (auth)

10850 TIME REVERSAL INVARIANCE IN SLOW NEUTRON CAPTURE. Bulgakov, M. I.; Danilyan, G. V.; Gulko, A. D.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Lett.; 42B: No. 3, 351-2(11 Dec 1972).

Time reversal invariance was studied by measuring the neutron polarization dependence of $\gamma-\gamma$ angular correlation for the 7.79 to 0.79-MeV cascade in the ^{35}Cl(n,γ)^{36}Cl reaction. The relative phase of the reduced matrix elements in the mixed electromagnetic transition in ^{36}Cl, caused by the T-noninvariant fraction of the nuclear Hamiltonian, was found to be $\eta = (-1.8 \pm 2.2) \times 10^{-3}$. (auth)

10851 STUDY OF (^{3}He,n) REACTIONS ON NUCLEI IN THE 2s–1d SHELL. Bass, R.; Friedland, U.; Hubert, B.; Nann, H.; Reiter, A. (Univ., Frankfurt am Main). Nucl. Phys.; A198: No. 2, 449-65(1972).

The (^{3}He,n) reaction was studied on ^{28}Si, ^{29}Si, ^{30}Si, ^{32}S, ^{35}Cl, and ^{37}Cl near 14 MeV bombarding energy. Angular distributions were measured for all ground-state transitions and for the transition to the first excited state in ^{30}S. The neutrons were detected with an arrangement of recoil proton telescopes, each consisting of two plastic scintillators. Pronounced L = 0 stripping patterns were observed for the ground-state transitions, with cross sections of the order of 1 mb/sr at 0°. The results are compared with DWBA calculations based on various sets of shell-model wave functions, and with (^{3}He,p) data for transitions to analogous final states. (auth)

10852 UNITARY-MODEL OPERATOR APPROACH TO STRUCTURE IN THE 2s–1d SHELL. Nisley, R. A.; Hull, M. H. Jr. (State Univ. of New York, Buffalo). Nucl. Phys.; A198: No. 2, 561-90(1972).

Effective two-body interactions are obtained from three realistic nucleon–nucleon potentials with different core structures by the unitary-model operator method and applications are made to the ground-state properties of doubly even N = Z nuclei by Hartree–Fock techniques. Structure calculations include determination of ground-state binding energies, radii, energy levels for the single-particle states, and deformations for the nuclei ^{16}O, ^{20}Ne, ^{24}Mg, ^{28}Si, ^{32}S, and ^{40}Ca. It is found that the binding is strongly dependent on the choice of the $^3S_1$ healing distance for both the Yale and Reid effective two-body interactions. By varying this parameter, quantitative agreement for the binding with the experimental values can be achieved. The deformations found are smaller than empirically expected but are qualitatively correct. (auth)

10853 PRECISION MEASUREMENT OF T = 3/2 STATES IN ^{25}Mg USING THE THRESHOLD PHOTONEUTRON TECHNIQUE. Berman, B. L.; Phillips, T. W. (Univ. of California, Livermore). Phys. Rev., C; 6: No. 6, 2295-8(Dec 1972).

The location in ^{25}Mg of the isobaric analog of the first excited state of ^{25}Na was measured to be 7864.5 ± 1.2 keV. Combining this result with other data yields a value for the coefficient of the cubic term in the isobaric-multiplet mass equation of –0.2 ± 4 keV. (auth)

10854 FERMI β-DECAY: THE HALF-LIVES OF ^{26m}Al, ^{34}Cl, ^{38m}K, AND ^{42}Sc. Hardy, J. C. (Chalk River Nuclear Labs., Ont.); Alburger, D. E. Phys. Lett.; 42B: No. 3, 341-3(11 Dec 1972).

Half-lives for ^{26m}Al, ^{34}Cl, ^{38m}K, and ^{42}Sc are measured to be 6351 ± 10, 1534 ± 3, 929.2 ± 3.5, and 684.5 ± 1.2 ms, respectively. The results for ^{34}Cl and ^{38m}K are substantially lower than previously accepted values and tend to bring the ft-values into agreement with other superallowed decays. The mirror asymmetry for mass 34 becomes Δ = (–2.5 ± 1.7)%. (auth)

10855 SCATTERING OF 8.0 AND 9.0 MeV NEUTRONS BY ^{27}Al, ^{28}Si, ^{31}P, AND ^{32}S. Brandenberger, J. D.; Mittler, A.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Nucl. Phys.; A196: No. 1, 65-82(1972).

Measurements were made of the differential elastic and inelastic cross sections for neutrons scattered by silicon at 7.71 MeV; and aluminum, silicon, phosphorus and sulfur at 7.97 and 9.05 MeV. Natural scattering samples were used. Finite sample corrections were made for the elastic scattering data. The elastic cross sections have rms relative and absolute uncertainties of 2–5% and 6–8% respectively. The inelastic cross sections have rms relative and absolute uncertainties of 3–8% and 6–10% respectively. All measured elastic cross sections were compared to theoretical calculations obtained by adding the shape elastic contribution from the optical model to the compound elastic contribution from the statistical model with level-width-fluctuation corrections. Theoretical calculations of the inelastic scattering from the first excited states of ^{28}Si and ^{32}S were made by summing the statistical and direct interaction predictions. The measurements agree with the models for ^{32}S. For ^{28}Si, only the 9.05 MeV measurements were in agreement with the models. The particle-core coupling model was used to compute the direct interaction contributions to the inelastic cross sections of the low-lying levels of ^{27}Al and ^{31}P. These predictions do not adequately describe the inelastic scattering of neutrons by ^{27}Al and ^{31}P. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 9696, 10353, 10809, 10814, 10820, 10829, 10834, 10835, 10838, 10839, 10842, 10843, 10881, and 11068.

10856 (ANL–7935) POLARIZATION IN THE ELASTIC SCATTERING OF NEUTRONS FROM MEDIUM- AND HEAVY-WEIGHT ELEMENTS. Cox, S. A.; Cox, E. E. D. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 39p. Dep. NTIS.

A systematic study of the differential elastic neutron scattering cross section and associated polarization for ~1-MeV neutrons is presented for 29 elements from titanium to uranium. The data for each element are averaged over an incident neutron energy range of 200–500 keV and compared with predictions of the optical-model and Hauser–Feshbach theories. The optical-model parameters that best fit the differential scattering data and polarizations exhibit a clear mass-number dependence. The real potential well depth (V) decreases monotonically from ~48 MeV at A = 60 to ~43 MeV at A = 238. The imaginary potential well depth (W) has a value of ~14 MeV at A = 60, goes through a minimum of ~10 MeV at A = 140, and then rises to a value of ~16 MeV at A = 238. The spin-orbit well depth (V_{so}) is essentially constant at ~6 MeV with an indication of a rise to ~7 MeV for A > 140. When V, W, and V_{so} are averaged over the mass number, the results agree very well with the generalized parameter set as proposed by Moldauer. There is an indication that the optical model combined with Hauser–Feshback theory provides a better description of the polarization phenomena for P-wave interactions than for S-wave interactions. (auth)

10857 (CONF-720701–(Absts.), pp 50-1) MEASUREMENT AND SYSTEMATICS OF (n,t) AND (n,^{3}He) REACTION CROSS SECTIONS AT 14.6 MeV. Qaim, S. M. (Kernforschungsanlage, Juelich, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10858 (CONF-720701–(Absts.), pp 60-1) MEASUREMENT OF THE ANGULAR DISTRIBUTION OF GAMMA RAYS IN RESONANT NEUTRON CAPTURE. Bhat, M. R.; Chrien, R. E.; Cole, G. W.; Mughabghab, S. F.; Wasson, O. A. (Brookhaven National Lab., Upton, N. Y.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10859 (CONF-720701-(Absts.), pp 104-5) CIRCULAR POLARIZATION OF CAPTURE γ-RADIATION IN THE $^{39}K(n,\gamma)^{40}K$ REACTION. (Reactor Centrum Nederland, Petten). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10860 (CONF-720701-(Absts.), pp 112-13) GAMMA SPECTROSCOPIC INVESTIGATIONS OF ^{46}Sc BY THE REACTION $^{45}Sc(n,\gamma)^{46}Sc$. Delang, W.; Goettel, P.; Seyfarth, H. (Kernforschungsanlage, Juelich, Ger.). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10861 (CONF-720701-(Absts.), pp 114-15) THERMAL NEUTRON CAPTURE IN ^{39}K. Goettel, P.; Delang, W.; Seyfarth, H. (Kernforschungsanlage, Juelich, Ger.). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10862 (CONF-720701-(Absts.), pp 176-7) FAST-NEUTRON SCATTERING FROM MANGANESE. Barnard, E.; de Villiers, J. A. M.; Malan, J. G.; Reitmann, D.; van der Merwe, P. (Atomic Energy Board, Pelindaba, S. Afr.). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10863 (CONF-720701-(Absts.), pp 244-5) RADIATIVE CAPTURE OF ENERGETIC NEUTRONS BY ^{40}Ca AND ^{208}Pb. Bergqvist, I.; Drake, D.; McDaniels, D. K. (Los Alamos Scientific Lab., NM). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10864 (INS-537) PROGRESS REPORT 18, JULY-DECEMBER 1971. (Institute of Nuclear Sciences, Lower Hutt (New Zealand)). Apr 1972. 100p. Dep. NTIS (U. S. Sales Only).
AGE ESTIMATION — research at INS, New Zealand, July-Dec. 1971
GEOCHEMISTRY — research at INS, New Zealand, July-Dec. 1971
INSTRUMENTS — research at INS, New Zealand, July-Dec. 1971
NUCLEAR PHYSICS — research at INS, New Zealand, July-Dec. 1971
RADIOISOTOPES — research at INS, New Zealand, July-Dec. 1971 (W.H.K.)

10865 ABSOLUTE REACTION CROSS SECTION OF THE REACTION $^{51}V(p,n)^{51}Cr$ OVER THE ISOBARIC ANALOG RESONANCE NEAR 2.340 MeV. Sekharan, K. K.; Mehta, M. K. (Bhabha Atomic Research Centre, Bombay). Phys. Rev., C; 6: No. 6, 2304-6(Dec 1972).

The shape of the isobaric analog resonance near 2.340 MeV in the reaction $^{51}V(p,n)^{51}Cr$ was determined with fine resolution (~1 keV) by utilizing a 4π-geometry neutron counter. It is shown that a negative value for the level-shift parameter Δ of the isobaric-analog-resonance theory is required to fit the data. The spectroscopic factor for the analog state at 12.8 MeV corresponding to this resonance is estimated to be 0.75 ± 0.15. (3 figures) (auth)

10866 β-DECAY OF ^{40}Cl. Klotz, G.; Gonidec, J. P.; Baumann, P.; Walter, G. (CRN, Strasbourg). Nucl. Phys.; A197: No. 1, 229-40(1972). (In French).

The γ-rays following the β^- decay of ^{40}Cl have been investigated with Ge(Li) and NaI(Tl) detectors. The ^{40}Cl sources were produced by fast-neutron bombardment of high-purity liquid argon samples. The half-life was measured to be 1.32 ± 0.02 min. Coincidence data for the prominent lines lead to a decay scheme accounting for 71 transitions, out of the 76 attributed to ^{40}Ar, between 37 levels. The ^{40}Cl β-ray branching was inferred from the relative γ-ray intensities. Evidence is found for 22 new β-branches. A previously reported strong β-group (20%) to the first excited state is shown to have an intensity <4%. The log ft values support $J^\pi = 2^-$ for the ground state of ^{40}Cl. (auth)

10867 Ti(τ,p) REACTIONS AT 15 MeV. I. $^{48}Ti(\tau,p)^{50}V$. Caldwell, T. (Univ. of Pennsylvania, Philadelphia); Hansen, O.; Pullen, D. J. Nucl. Phys.; A198: No. 2, 529-41(1972).

The $^{48}Ti(^3He,p)^{50}V$ reaction was studied at 15 MeV incident energy by using a multiangle spectrograph. Ninety-eight transitions up to 8.58 MeV in excitation were identified, and many of the corresponding proton angular distributions were measured. The distribution shapes together with DW calculations allowed the assignment of a number of new spin and parity values. The results are compared with other data on ^{50}V. The isobaric spin ($^3He,p$) intensity relations are applied to $0^+ \rightarrow 0^+$ transitions to T = 2 and T = 3 states in ^{50}V, and it is found that the T = 2 level takes up less than ¼ of the expected antianalog strength. The $0^+ \rightarrow 1^+$ ($^3He,p$) transition strength is found to be ≈3 times larger than possible within an f-p configuration space. (3 figures, 1 table). (auth)

10868 EXCITATION OF THE PARENT ANALOGS OF THE ^{58}Ni GIANT M1 RESONANCE BY THE REACTION $^{58}Ni(t,h)^{58}Co$. Flynn, E. R.; Garrett, J. D. (Los Alamos Scientific Lab., NM). Phys. Rev. Lett.; 29: No. 26, 1748-51(25 Dec 1972).

The reaction $^{58}Ni(t,h)^{58}Co$ has been studied at an incident triton energy of 23.5 MeV. Among the low-lying levels are several 1^+ states which are selectively populated. Based on this selectivity and their energy centroid, it is proposed that these states contain an appreciable fraction of the $T_0 + 1$ analogs of the giant M1 resonance in ^{58}Ni. (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 9699, 10795, 10809, 10814, 10839, 10843, 10856, and 10857.

10869 (BNL-tr-509) MEASUREMENT OF THE CROSS SECTION FOR THE REACTION $^{80}Kr(n,\gamma)^{81}Kr$ PRODUCED BY THERMAL NEUTRONS. Barabanov, I. R.; Pomanskii, A. A.; Ryasnyi, V. G. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 11, 643-5(1972). 5p. Dep. NTIS.
An abstract of this paper, prepared from the original language, appeared as NSA 26: 57677. (TSS)

10870 (CONF-720701-(Absts.), pp 22-3) ANISOTROPY OF γ RAYS FROM POLARIZED NEUTRON CAPTURE IN ORIENTED NUCLEI ^{59}Co. Honzatko, J.; Sebek, J.; Kajfosz, J.; Stehno, J.; Kosina, Z.; Konecny, K.; Juna, J. (Inst. of Nuclear Physics, Rez, Czech.). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10871 (CONF-720701-(Absts.), pp 24-5) STUDY OF THE $^{59}Co(n,\gamma)$ REACTION WITH POLARIZED NEUTRONS AND POLARIZED NUCLEI. Reddingius, E. R.; Bosman, J. J.; Postma, H. (Reactor Centrum Nederland, Petten). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10872 (CONF-720701-(Absts.), pp 26-7) ANGULAR DISTRIBUTION OF GAMMA RAYS EMITTED AFTER CAPTURE OF THERMAL NEUTRONS BY ORIENTED NUCLEI. Bosman, J. J.; Reddingius, E. R.; Postma, H. (Reactor Centrum Nederland, Petten). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10873 (CONF-720701-(Absts.), pp 94-5) GAMMA RAY TRANSITIONS FROM keV CAPTURE IN NICKEL. Kenny, M. J.; Martin, P. W.; Bird, J. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10874 (CONF-720701-(Absts.), pp 208-9) NEUTRON CAPTURE CROSS SECTION MEASUREMENTS FOR ^{86}Sr, ^{87}Sr, AND ^{88}Sr. Vanpraet, G. J. (Oak Ridge National Lab., TN); Macklin, R. L.; Allen, B. J.; Winters, R. R. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10875 (CONF-720701-(Absts.), pp 252-3) MASS DEPENDENCE OF THE CROSS SECTION FOR THE RADIATIVE CAPTURE OF 14 MeV NEUTRONS. Cvelbar, F.; Budnar, M.; Hodgson, E.; Potokar, M. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10876 (FRNC-TH-270) STUDY OF THE DISINTEGRATION OF ^{76}As AND THE EXCITED LEVELS OF ^{76}Se. Funel, Genevieve (Nice Univ. (France). Faculte des Sciences). 1971. 123p. (In French). Dep. NTIS (U. S. Sales Only).
Thesis.
The γ-ray spectrum of ^{76}As was examined. 14 new lines were discovered. The existence of most of the levels was verified by γ-γ coincidence measurements. The J^π character of some particular levels was determined from the β transition selection rules, and formulas giving the transition probabilities. An at-

tempt was made to class the excited levels of ^{76}Se into rotational bands using the variable moment of inertia model. (France)

10877 STUDY OF LOW-LYING ^{86}Rb LEVELS IN THE ^{87}Rb(τ,α)^{86}Rb REACTION. Fou, C. M. (Univ. of Delaware, Newark). Nucl. Phys.; A192: No. 1, 139-44(1972).

The low-lying levels in ^{86}Rb were investigated via the ^{87}Rb(^{3}He, α)^{86}Rb reaction with a 16 MeV ^{3}He beam. Nine excited levels at 0.49, 0.56, 0.87, 0.98, 1.02, 1.09, 1.42, 1.66, and 2.12 MeV excitation were identified. A distorted-wave analysis was performed yielding spectroscopic information about these levels. (auth)

10878 MAGNETIC MOMENT OF ^{59}Fe. Daly, P. W.; Gorling, R. L. A.; Martin, P. W.; Turrell, B. G. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 19, 2373-5(1 Oct 1972).

Measurement of γ-ray anisotropies from ^{59}Fe nuclei oriented in pure iron was attempted. The negative result allows one to put a limit of 0.9 n.m. on the magnetic moment. (auth)

10879 STUDY OF THE (d,p) REACTION ON ^{62}Ni NEAR THE COULOMB BARRIER. Sykes, D.; Ramavataram, K.; Mercier, G. F.; St-Pierre, C.; Yang, C. S. (Univ. Laval, Quebec). Can. J. Phys.; 50: No. 18, 2096-9(15 Sep 1972).

The absolute differential cross sections for the ^{62}Ni(d,p)^{63}Ni reaction were measured at deuteron bombarding energies of 4.45 and 5.12 MeV. Spectroscopic factors were obtained and the results are discussed in terms of the DWBA model of stripping reactions. It is found that this technique leads to reliable and stable values of the spectroscopic factor even for states which carry less than half the single particle strength. (auth)

10880 DE-EXCITATION SCHEME OF ^{78}Br. Lehmann, J.; Vanuffelen, M.; Vervier, J. J. Phys. (Paris); 33: No. 5, 465-72 (May 1972). (In French).

The γ-ray spectrum emitted during the decay of ^{78}Br($T_{½}$ = 6.4 minutes) was measured with Ge(Li) detectors. The results were used to obtain information on the energy levels of ^{78}Se. (auth)

10881 SHELL-MODEL CALCULATIONS ON THE NICKEL ISOTOPES. Glaudemans, P. W. M.; de Voigt, M. J. A.; Steffens, E. F. M. (State Univ., Utrecht). Nucl. Phys.; A198: No. 2, 609-24(1972).

Binding and excitation energies, electromagnetic transition rates, and multipole moments were calculated for $^{57-66}$Ni from many-particle shell-model wave functions with neutrons in the $2p_{½}$, $1f_{½}$, and $2p_{½}$ orbits outside the ^{56}Ni core. The effective two-body matrix elements were obtained from the modified surface-delta interaction. The average absolute deviation between the calculated and experimental binding and excitation energies is 0.11 MeV (with the exclusion of ^{66}Ni). Electric quadrupole transition rates and moments are calculated with an effective neutron charge e_n = (1.70 ± 0.08)e, obtained from a least-squares fit to experimental data. Magnetic dipole transition rates and moments follow from five fitted effective reduced single-particle matrix elements. The average absolute deviations between theory and experiment for the strongest E2 transitions (1 to 15 W.u.) and for the strongest M1 transitions (0.01 to 0.14 W.u.) are 3.5 and 0.03 W.u., while the average measured strengths are 7.0 and 0.07 W.u., respectively. (14 figures, 3 tables). (auth)

10882 EXCITATION FUNCTIONS OF (p,n) AND (α,n) REACTIONS ON Ni, Cu, AND Zn. Hille, M. (Technische Univ., Munich; Hille, P.; Uhl, M.; Weisz, W. Nucl. Phys.; A198: No. 2, 625-40(1972).

Cross sections for the reactions ^{63}Cu, ^{66,68}Zn(p,n) and ^{60}Ni, ^{63,65}Cu(α,n) were measured using the activation method. The energy interval was 9 to 16 MeV for protons and 19 to 23.5 MeV for the incident α particles. By using experimental data from the literature, the excitation functions could be extended to a larger energy interval. The experimental excitation functions are compared with theoretical predictions of the statistical model with consideration of "pre-equilibrium" particle emission. The role of γ competition to particle emission and the influence of the pre-equilibrium-model parameters are discussed. (12 figures, 2 tables). (auth)

10883 NUCLEAR DATA SHEETS FOR A = 70. Alvar, K. R. (Rutgers—The State Univ., New Brunswick, N. J.); Raman, S. Nucl. Data, Sect. B; 8: No. 1, 1-27(Jul 1972).

The 1966 version of the Nuclear Data Sheets for A = 70 has been revised on the basis of experimental data received before June 1, 1972. Experimental data, arguments for J^{π} assignments, and detailed level schemes are presented. A large amount of new information is given for the ^{70}Zn, ^{70}Ga, and ^{70}Ge level schemes, while essentially no new information is available for the level schemes of ^{70}Cu and ^{70}As. (auth)

10884 DEUTERON STRIPPING AND THERMAL NEUTRON CAPTURE γ REACTIONS ON THE ^{72,74,76}Ge ISOTOPES. Hasselgren, A. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys.; A198: No. 2, 353-79(1972).

(d,p) stripping reactions at 12 MeV bombarding energy and (n_{th},γ) reactions on ^{72,74,76}Ge were carried out. New energy levels below 4 MeV excitation energy were determined, and new l_n values were assigned from a DWBA analysis. Spectroscopic information and decay schemes were deduced. A sum-rule analysis was made for the $2p_{½}$, $1f_{½}$, $2p_{½}$, and $1g_{½}$ single-particle states, and the results were compared with pairing theory. Low-lying l = 0 states were found in ^{73,75}Ge. No correlation was obtained between the (d,p) strengths and (n,γ) strengths for l_n = 1 levels. (14 figures, 14 tables). (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 9675, 9691, 9939, 10353, 10795, 10809, 10856–10858, 10953, and 10973.

10885 (CONF-720701-(Absts.), pp 12-13) METHOD OF SPIN ASSIGNMENT OF BOUND LEVELS POPULATED BY (n,γ) REACTIONS. Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M. (CBNM—Euratom, Geel, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10886 (CONF-720701-(Absts.), pp 20-1) DETERMINATION OF SPINS OF NEUTRON RESONANCES BY THE GAMMA-RAY MULTIPLICITY METHOD. Karzhavina, E. N.; Kim Sek Su; Popov, A. B. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10887 (CONF-720701-(Absts.), pp 34-5) STUDY OF THE (n,γ) SPECTRA IN THE RESONANCES OF ANTIMONY. Lottin, A.; Jain, A.; Paya, D. (CEN de Saclay, Gif-sur-Yvette, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10888 (CONF-720701-(Absts.), pp 54-5) GAMMA-RAYS FROM RESONANCE NEUTRON CAPTURE IN ^{143}Nd. Weigmann, H.; Rohr, G. (CBNM-Euratom, Geel, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10889 (CONF-720701)(Absts.), pp 72-3) (n,γ) INVESTIGATION OF THE LEVEL STRUCTURE IN ^{92}Zr. Fanger, U.; Heck, D.; Pepelnik, R.; Schmidt, H.; Wood, J. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10890 (CONF-720701-(Absts.), pp 74-5) GAMMA-RAYS FROM RESONANCE NEUTRON CAPTURE IN ^{115}In. Stefanon, M.; Corvi, F.; Coceva, C.; Giacobbe, P. (CNEN, Bologna). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10891 (CONF-720701-(Absts.), pp 82-3) LEVEL SCHEME OF ^{116}In. Alexeev, V. L.; Emelianov, V. A.; Kabina, L. P.; (and others) (Inst. of Nuclear Physics, Leningrad). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10892 (CONF-720701-(Absts.), pp 92-3) keV NEUTRON CAPTURE NEAR A = 100. Bird, J. R.; Pattenden, N. J.; Kenny, M. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10893 (CONF-720701-(Absts.), pp 96-7) GAMMA SPECTROSCOPY STUDIES OF THE REACTION ^{104}Ru$(n_{th},\gamma)^{105}$Ru. Hrastnik, B.; Hassan, A. M.; Seyfarth, H.; Delang, W.; Goettel, P. (Kernforschungsanlage, Juelich, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10894 (CONF-720701-(Absts.), pp 116-17) INVESTIGATION OF THE ^{103}Ru LEVEL SCHEME BY THERMAL NEUTRON CAPTURE. Seyfarth, H.; Hassan, A. M.; Hrastnik, B.; Delang, W.; Goettel, P. (Kernforschungsanlage, Juelich, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10895 (CONF-720701-(Absts.), pp 120-1) LEVELS OF ^{93}Nb VIA THE (n,n'γ) REACTION. van Heerden, I. J.; McMurray, W. R. (Southern Universities Nuclear Inst., Faure, S. Afr.). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10896 (CONF-720701-(Absts.), pp 122-3) NUCLEAR STRUCTURE STUDIES USING DELAYED NEUTRON SPECTROMETRY. Shalev, S.; Rudstam, G. (Swedish Research Council's Lab., Studsvik). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10897 (CONF-720701-(Absts.), pp 128-9) LOW-LYING EXCITED STATES OF ^{145}Nd POPULATED BY THE CAPTURE OF THERMAL NEUTRONS. McClure, D. A. (Georgia Inst. of Tech., Atlanta); Raman, S.; Harvey, J. A. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10898 (CONF-720701-(Absts.), pp 140-1) ALPHA-PARTICLE WIDTHS OF NEUTRON RESONANCES FOR NUCLEI FROM THE RARE EARTH REGION. Balabanov, N. P.; Popov, Yu. P.; Semenov, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10899 (CONF-720701-(Absts.), pp 148-9) FAST NEUTRON SCATTERING FROM ^{120}Sn AND Gd. Tanaka, S.; Tomita, Y.; Yamanouti, Y.; Ideno, K. (Japan Atomic Energy Research Inst., Tokai). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10900 (CONF-720701-(Absts.), pp 188-9) ANOMALIES IN ANGULAR DISTRIBUTIONS OF NEUTRON SCATTERING BY La AND Pr NUCLEI IN THE ENERGY RANGE 1 eV TO 0.26 MeV. Mirzaakhmedov, M.; Samosvat, G. S. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10901 (CONF-720701-(Absts.), pp 190-1) CROSS SECTIONS FOR THE (n,n') AND (n,2n) REACTION IN THE ^{113}In AND ^{204}Pb NUCLEI. Decowski, P.; Grochulski, W.; Karolyi, J.; Marcinkowski, A.; Piotrowski, J.; Saad, E.; Wilhelmi, Z. (Inst. of Nuclear Research, Warsaw). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10902 (CONF-720701-(Absts.), pp 216-7) OBSERVATION OF VALENCE NEUTRON TRANSITIONS IN THE REACTION ^{108}Pd(n,γ)^{109}Pd. Mughabghab, S. F.; Kane, W. R.; Casten, R. F. (Brookhaven National Lab., Upton, NY). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10903 (CONF-720701-(Absts.), pp 222-3) TEST OF THE VALENCY MODEL OF NEUTRON CAPTURE IN ^{92}Mo + NEUTRON. Wasson, O. A.; Slaughter, G. G. (Oak Ridge National Lab., TN). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10904 (CONF-720701-(Absts.), pp 228-9) CORRELATIONS BETWEEN (n,γ) AND (d,p) REACTION ON ^{139}La AND ^{176}Lu. Fubini, A.; Prosperi, D. (CNEN, Rome). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10905 (CONF-720701-(Absts.), pp 230-1) TEST OF VALENCY NEUTRON MODEL IN ^{141}Pr(n,γ)^{142}Pr REACTION. Becvar, F.; Huynh Thuong Hiep; Pospisil, S.; Sacha, J.; Telezhnikov, S. A. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10906 (CONF-720701-(Absts.), pp 238-9) MAPPING OF CORRELATIONS BETWEEN NEUTRON WIDTH AND RADIATIVE CAPTURE WIDTH IN Sb, I, AND Cs. Jain, A. P.; Lottin, A. (CEN de Saclay, Gif-sur-Yvette, France). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10907 (LA-DC-72-209) OBSERVATION OF A LONG-LIVED ISOMERIC STATE OF ^{92}Nb. Knight, J. D. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 12p. Dep. NTIS.

The discovery of a very long-lived isomeric state of ^{92}Nb, produced in a sample of molybdenum that had been given a long exposure in the core of the Omega West reactor at Los Alamos, is reported. Based on an estimated ratio $N(^{92}Nb)/N(^{94}Nb)$ of the numbers of the atoms of the two isotopes produced by (n,p) on molybdenum with the high-energy end of the reactor neutron spectrum, the half-life of the long-lived state is approximately 1×10^8 years. The experimental determination of this atom ratio in the Nb sample is as yet unavailable, but it is not likely to affect the half-life by a factor of more than 5. (auth)

10908 IMPROVED NUMERICAL METHOD FOR DETERMINING COMPOSITE DECAY CONSTANTS. Higbie, J. (Univ. of Queensland, Brisbane). Nucl. Instrum. Methods; 105: No. 2, 279-83(1972).
An exponential weighted least-squares-fit technique is presented which can be used on β activity data from a composite source. The method is fundamentally and conceptually superior to the standard technique, which consists of a linear fit to logarithmic data. The linear–log technique is shown to contain a systematic error, which is not present in the exponential–fit technique presented here. The exponential-fit technique takes the results of the standard linear–log fit as a first approximation and proceeds to its final result by iteration. (2 figures) (auth)

10909 INVESTIGATION OF ^{93}Mo LEVELS VIA THE ^{94}Mo(τ,α)^{93}Mo REACTION. Fou, C. M. (Univ. of Delaware, Newark). Nucl. Phys.; A192: No. 1, 145-50(1972).
Levels in ^{93}Mo were investigated via the ^{94}Mo(^{3}He,α)^{93}Mo reaction with a 16 MeV ^{3}He beam. Angular distributions for ten states in ^{93}Mo were measured. DWBA analysis was performed to determine the angular momentum transfers involved. Tentative spin and parity assignments were made and were compared with the results of previous experimental studies found in the literature. Three new levels $E_x = 3.27 \pm 0.03$ MeV, l = 4; $E_x = 3.42 \pm 0.03$ MeV, l = 2; and $E_x = 3.58 \pm 0.03$ MeV, l = 4 were identified. (auth)

10910 STUDY OF THE (^{3}He,d) REACTION ON EVEN MOLYBDENUM ISOTOPES. Shamai, Y. (Tel-Aviv Univ., Israel); Ashery, D.; Yavin, A. I.; Bruge, G.; Chaumeaux, A. Nucl. Phys.; A197: No. 1, 211-28(1972).
A study of single-particle proton strengths in odd-mass Tc isotopes was performed using the (^{3}He,d) reaction. Angular distributions were measured from 8 to 70° and compared with calculations using the distorted-wave Born approximation. The l-values and spectroscopic factors were extracted and compared with (d,n) results. Proton configurations for the ground states of ^{92,94}Mo and ^{96}Mo were deduced from the analysis. Symmetry energies were extracted from the energy difference between the centroids of the T > and T < states. Various methods for DWBA calculations for unbound states are discussed. (auth)

10911 ELASTIC ELECTRON–TIN SCATTERING. Ficenec, J. R. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Fajardo, L. A.; Trower, W. P.; Sick, I. Phys. Lett.; 42B: No. 2, 213-15(27 Nov 1972).
Elastic differential cross sections for 330-MeV electrons on the nine stable tin isotopes were measured. A family of simple charge distributions was postulated and a phase shift analysis performed. The charge distribution parameters are displayed as a function of mass number for the modified Gaussian fit which was performed. (auth)

10912 EFFECTIVE RESONANCE INTEGRALS OF MOLYBDENUM, TUNGSTEN, AND TANTALUM IN SLAB GEOMETRY. Heimel, H.; Heindler, M. (Technische Hochschule, Graz). Atomkernenergie; 20: No. 2, 135-42(1972). (In German).
Central sub-cadmium reactivity coefficients of molybdenum, tungsten, and tantalum were measured in the Siemens Argonaut Reactor at Graz. Effective resonance integrals were calculated by means of the neutron transport code DKHAIR for Mo and W in slab geometry as a function of plate thickness. For that purpose cross sections were derived from the ENDF/B nuclear data file using the codes CARLERESONNE and SIGMAS MOYENNES. A check by the integral transport code REINT showed that, in the range of plate thicknesses studied, the approximations which DKHAIR is based on lead to neglegible errors. In the case of molybdenum the calculated effective resonance integrals and the measured values of specific reactivity depend to the same extent on the sample thickness. The cross section library as well as the experimental procedures used were, therefore, proved to be reliable. Because the experimental uncertainties are very small, the deviations in the case of tungsten can be attributed to the cross sections. In order to reveal the sources of these errors, further measurements with samples of increased thickness are planned. For that purpose a modification of the DKHAIR code is necessary. (auth)

10913 SLOW NEUTRON RESONANCES OF ANTIMONY. Ohkubo, Makio; Nakjima, Yutaka; Asami, Akira; Fuketa, Toyojiro (Japan Atomic Energy Research Inst., Tokai). J. Phys. Soc. Jap.; 33: No. 5, 1185-96(Nov 1972).

The total neutron cross section of natural antimony has been measured by the transmission method using the time-of-flight spectrometer of the JAERI linear accelerator with the maximum time resolution of 10 nsec/m. The resonance energies of about 100 levels below 1400 eV have been determined. The neutron widths of 47 levels below about 400 eV and the total widths of 11 levels out of those 47 levels have been obtained by the area analysis and the thick-thin method. The isotope assignments of resonances by others are utilized in the analyses. The average level spacings and the strength functions for the energy region below 350 eV are obtained to be $\langle D\rangle = 7.5 \pm 0.5$ eV and $S = (0.26 \pm 0.06) \times 10^{-4}$ for natural Sb, $\langle D\rangle = 11 \pm 1$ eV and $S_0 = (0.23 \pm 0.07) \times 10^{-4}$ for ^{121}Sb, and $\langle D\rangle = 25 \pm 3$ eV and $S_0 = (0.28 \pm 0.1) \times 10^{-4}$ for ^{123}Sb, respectively. (auth)

10914 PROPERTIES OF $^{130}Te_{78}$ AS OBSERVED IN THE 40 MIN β-DECAY OF ^{130}Sb. Kerek, A.; Carle, P.; McDonald, J. (Research Inst. for Physics, Stockholm). Nucl. Phys.; A198: No. 2, 466-80(1972).

Gamma-ray and conversion-electron spectra associated with the decay of 40-min ^{130}Sb were measured with Ge(Li) and Si(Li) detectors. The antimony samples were produced using the on-line isotope separator OSIRIS to isolate the fission products from ^{235}U. On the basis of the measured singles and $\gamma-\gamma$ coincidence spectra, a new level scheme was constructed. The most important states observed are 839.4 keV, 2^+; 1632.8 keV, 4^+; 1815.1 keV, 6^+; 2100.8 keV, 5^-; and 2146.0 keV, 7^-. By using delayed coincidence techniques a half-life of 9.8 ± 0.5 ns was deduced for the 6^+ state. This implies that the 182.3-keV transition connecting the 6^+ and 4^+ states has $B(E2)_{exp} = 240 \pm 12\ e^2 \cdot fm^4$. This value is 2.8 times greater than that theoretically predicted if both states are assumed to be pure $(g_{7/2})^2$ two-proton configurations. The $T_{1/2}$ for the 7^- state was determined to be 115 ± 8 ns, this value giving a hindrance factor of 1.8×10^7 with respect to the Weisskopf estimate for the 330.9 keV $7^- \rightarrow 6^+$ E1 transition. The origins of the 5^- and 7^- states are ascribed mainly to the $(1h_{11/2}, 3s_{1/2})$ and $(1h_{11/2}, 2d_{3/2})$ two-neutron configurations, respectively. (auth)

10915 NUCLEAR DATA SHEETS FOR A = 95. Medsker, L. R. (Argonne National Lab., Ill.); Horen, D. J. Nucl. Data, Sect. B; No. 1, 29-76(Jul 1972).

The 1960 version of the Nuclear Data Sheets for A = 95 has been revised on the basis of experimental data received prior to May 1972. Information from approximately 175 papers and communications has been included in the present compilation. The data have been examined and utilized to construct level and decay schemes. Inconsistencies in the data are indicated either by direct comparison or in footnotes. Reported normalizations for the decay of ^{95}Y differ considerably. For the stable nucleus ^{95}Mo, approximately 60 levels are known; however, firm spin assignments can be made for only a few of these, mainly below 1.5 MeV. A similar situation exists in other nuclei in this mass chain. The present compilation might serve as a basis for choosing definitive experiments which would augment our knowledge in this mass chain. (auth)

10916 NUCLEAR DATA SHEETS FOR A = 127. Auble, R. L. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B; 8: No. 2, 77-121(Aug 1972).

Nuclear structure data for the nine known members of the A = 127 mass chain are compiled, and adopted level properties and decay schemes are presented. The compilation is based on selected data from approximately 120 references available through June 1972. Included are eleven pages of drawings showing in pictorial form the bulk of the adopted values. These are followed by tabular data listings and summaries of level properties and gamma-ray properties for each member of the A-chain. Adopted decay schemes are discussed following the data for each radioactive nucleus. These sections also include the normalization factor used to relate absolute photon intensities with the relative values generally reported in the literature. Possible inconsistencies or errors in the data are also noted through the compilation. (auth)

10917 NUCLEAR DATA SHEETS FOR A = 129. Horen, D. J. (Oak Ridge National Lab., Tenn.) Nucl. Data, Sect. B; 8: No. 2, 123-63(Aug 1972).

The literature pertaining to nuclei in the A = 129 mass chain has been examined and the experimental data summarized in the present compilation. A minimum of numerical data is included. Few definitive spin and parity assignments could be made. Decay data for ^{129}Ba indicate the existence of two isomers with nearly equal half-lives. Using unpublished results, the compilers propose to consist of the g.s., $J^\pi = 1/2^+$, and a level at 0.2771 MeV, $J^\pi = (11/2^-)$. Efforts have been made to indicate apparent discrepancies in the data. The present compilation might serve as a basis for choosing definitive experiments to augment our knowledge of nuclei in this mass chain. (auth)

10918 NUCLEAR SPINS OF NEUTRON-DEFICIENT Pr and Nd ISOTOPES. Ekstroem, C. (Univ. of Uppsala); Ingelman, S.; Olsmats, M.; (and others). Nucl. Phys.; A196: No. 1, 178-96 (1972).

The atomic-beam magnetic resonance method has been used in spin measurements on some neutron-deficient praseodymium and neodymium isotopes. The results are: ^{133}Pr (7.5 min) $I = 5/2$, ^{134}Pr (18.5 min) $I = 2$, ^{135}Pr (24 min) $I = 3/2$, ^{136}Pr (13.5 min) $I = 2$, ^{137}Pr (76.6 min) $I = 5/2$, ^{138m}Pr (2.0 h) $I = 7$, ^{139}Pr (4.5 h) $I = 5/2$, ^{140}Pr (3.4 min) $I = 1$, ^{134}Nd (8 min) $I = 0$, ^{135}Nd (15 min) $I = 9/2$, ^{136}Nd (55 min) $I = 0$, ^{137}Nd (37 min) $I = 1/2$, ^{138}Nd (5.2 h) $I = 0$, ^{139}Nd (29.7 min) $I = 3/2$, ^{139m}Nd (5.5 h) $I = 0$, and ^{140}Nd (3.38 d) $I = 0$. The spin values of nuclei in the vicinity of the N = 82 shell closure are in agreement with shell-model predictions. In order to explain the nuclear spins of the neutron-deficient isotopes far from the β-stability line, a deformed nuclear shape has to be assumed. (auth)

10919 MAGNETIC MOMENTS OF THE 295 AND 357 keV STATES OF ^{103}Rh. Szoekefalvi-Nagy, Z.; Demeter, I.; Keszthelyi, L.; Mezei, G.; Varga, L. (Central Research Inst. for Physics, Budapest). Nucl. Phys.; A196: No. 1, 58-64(1972).

The g-factors of the 295 and 357 keV excited states of ^{103}Rh measured by Coulomb excitation in Fe–Rh alloy were found to be 0.28(16) and 0.54(3) respectively. The cascade decay of the 357 keV level was carefully taken into account in the evaluation of the 295 keV energy case. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 10795, 10856, 10885, 10898, 10899, 10904, 10912, and 10945.

10920 (CONF-720701–(Absts.), pp 8-9) MAGNETIC MOMENTS OF ^{168}Er STATES EXCITED BY NEUTRON CAPTURE. Alfimenkov, V. P.; Zhukov, G. P.; Zimin, G. N.; Lason, L.; Mareev, Yu. D.; Ovchinnikov, O. N.; Pikelner, L. B.; Tishin, V. G.; Shapiro, F. L.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10921 (CONF-720701)-(Absts.), pp 16-17) KNOCK-ON MECHANISM FOR (n,α) REACTIONS INDUCED BY 18 MeV NEUTRONS ON ^{160}Dy, ^{162}Dy, AND ^{164}Dy. Glowacka, L.; Jaskola, M.; Kozlowski, M.; Osakiewicz, W.; Turkiewicz, J.; Zemlo, L. (Inst. of Nuclear Research, Warsaw). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10922 (CONF-720701–(Absts.), pp 38-9) MEASUREMENT AND ANALYSIS OF TOTAL CROSS-SECTION OF ^{169}Tm AND ^{165}Ho. Tellier, H.; Alix, M.; Jain, A. P. (CEN de Saclay, Gif-sur-Yvette, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10923 (CONF-720701–(Absts.), pp 52-3) POSSIBLE SPIN DEPENDENCE OF AVERAGE RADIATIVE WIDTHS IN ^{177}Hf + n. Rohr, G.; Weigmann, H. (CBNM–Euratom, Geel, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10924 (CONF-720701-(Absts.), pp 98-9) INVESTIGATIONS OF NANOSECOND ISOMERIC TRANSITIONS IN ^{177}Lu AND ^{187}W USING THE (n,γ) REACTION. Andrejtscheff, W.; Manfrass, P.; Prade, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10925 (CONF-720701–(Absts.), pp 102) NUCLEAR LEVELS IN ^{160}Tb. Kern, J. (Univ., Fribourg, Switzerland); Mauron, G.; Michaud, B.; Koch, R.; Maier, B. P. K.; Breitig, D.; Schult, O. W. B.; Schreckenbach, K.; Egidy, T. v.; Mampe, W. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10926 (CONF-720701–(Absts.), pp 214-15) NONSTATISTICAL EFFECTS IN THE 4s GIANT RESONANCE. Mughabghab, S. F. (Brookhaven National Lab., Upton, NY); Bhat, M. R.;

Bartholomew, G. A.; Chrien, R. E.; Cole, G. W.; Wasson, O. A.; Slaughter, G. G. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10927 (CONF-720701-(Absts.), pp 226-7) SEARCH FOR DIRECT CAPTURE AND NON-STATISTICAL EFFECTS IN $^{162}Dy(n,\gamma)^{163}Dy$. Cole, G. W.; Mughabghab, S. F.; Chrien, R. E. (Brookhaven National Lab., Upton, NY). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10928 (CONF-720701-(Absts.), pp 254-5) INFLUENCE OF QUANTUM NUMBER K ON THE INTENSITY OF PARTIAL GAMMA TRANSITIONS FROM THE $^{177}Hf(n,\gamma)^{178}Hf$ REACTION AT THE NEUTRON RESONANCES. Danelyan, L. S. (Inst. of Atomic Energy, Moscow); Kardon, B. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10929 (CONF-720701-(Absts.), pp 262-3) FAST NEUTRON CAPTURE γ-RAYS FROM HEAVY ELEMENTS. Earle, E. D. (Chalk River Nuclear Labs., Ont.); Lone, M. A.; Bartholomew, G. A.; McDonald, W. J.; Bray, K. H.; Moss, G. A.; Nielson, G. C. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10930 (FEI-235) ANGULAR ANISOTROPY AND FISSION CROSS SECTION OF NUCLEI IN THE REGION Z = 73 TO 83 FOR α PARTICLES WITH ENERGY 38 MeV. Kuvatov, K. G.; Okolovich, V. N.; Smirina, L. A.; Smirenkin, G. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 20p. (In Russian). Dep. NTIS (U.S. Sales Only).

The angular distribution of fission fragments and the fission cross sections were measured for 18 isotopes from ^{181}Ta to ^{209}Bi using 38 MeV α particles. The data were analyzed with statistical theory, yielding information on the effective moments of inertia in the transition state and the shell structure of the density of levels of equilibrium nuclei at ~30 MeV excitations. (tr-auth)

10931 (FRNC-TH-280) NUCLEAR SPECTROMETRY (^{155}Tb AND ^{172}Tm) AND ISOTOPIC SEPARATION. Barat, J.-L. (Universite Scientifique et Medicale de Grenoble (France)). 1972. 69p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The excited levels of ^{155}Tb were studied from its radioactive emission in view of defining the intrinsic states (both particle and vibrational states). The excited levels of ^{172}Tm were also studied. The energies are stated. The scheme already proposed by Hanser was completed. The four new transitions established further confirm the disintegration scheme, which can only be interpreted in terms of configuration mixing. In the field of radioactive emission spectrometry, the two previous investigations demonstrate that an isotope separator may be indispensable for a cyclotron, reactions of the (α,xn) or (p,xn) type not being sufficiently selective with respect to the energy of the incident particle. The ion extraction system and the magnet of the ISN isotope separator were improved in the framework of these investigations. The field of production was extended toward short-lived nuclides by adopting a quadrupolar lens to focus the selected beam. (France)

10932 (FRNC-TH-281) STUDY OF M2 TRANSITIONS IN DEFORMED NUCLEI. Erbil, H. H. (Universite Scientifique et Medicale de Grenoble (France)). 1972. 102p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The M2 transitions occurring in the following nuclei are studied: four odd proton deformed nuclei and two odd neutron deformed nuclei in the rare earth region (^{165}Ho, ^{181}Ta, ^{183}Re, ^{187}Re, ^{191}W, ^{187}Os); two odd proton deformed nuclei in the actinide region (^{237}Np and ^{249}Bk). Three transitions in two even neutron and proton deformed nuclei (^{180}W and ^{182}W) were also studied. Cases in which the experimental values of the M2 transitions are questionable or the K transitions forbidden have deliberately been excluded from this study. The Nilsson model was first considered by itself and then with the Boisson-Piepenbring (B-P) prescriptions. It was noted that the B-P effects considerably improve the results. The pairing effect was calculated together with functions (without blocking and without conservation of the number of particles). The collective rotational part of the multipolar moment operator and the second order term of the collective M2 vibrational type transitions were neglected. In odd mass nuclei, the pairing effects on the M2 transition are not very important in relation to those encountered in the study of E1 transitions. The collective effects do not effect the calculation of the M2 transitions to any great extent. In the even nuclei the collective effects play an important role. For the nuclei having odd mass the Coriolis coupling was taken into consideration. The treatment was made using 1st-order perturbation calculations. (France)

10933 MOESSBAUER EFFECT OF THE 60.0 keV TRANSITION IN ^{155}Gd AND THE 54.5 keV TRANSITION IN ^{157}Gd. Goering, J.; Herbig, R. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 27a: No. 11, 1684-5(Nov 1972).

Using the Mössbauer technique the lifetimes of the 60.0 keV level in ^{155}Gd and the 54.5 keV level in ^{157}Gd have been measured. (auth)

10934 MONOENERGETIC POSITRON LINE AND OTHER POSITRON DISTRIBUTIONS IN THE ^{152}Eu DECAY. Svahn, B.; Bergman, C.; Pettersson, H. (Univ. of Uppsala). Phys. Scr.; 5: No. 1-2, 23-6(1972).

The monoenergetic K-positron line from the 1408-keV transition in ^{152}Sm was sought using an intense ^{152}Eu source in a double-focusing spectrometer equipped with a cooled Si(Li) detector. It was realized that the edge of the internal pair positrons from the 1458-keV E1 transition was located close to the expected position of the positron line. The intensity of the K-positron line to that of the 1408-keV gamma transition was determined as $(3.1 \pm 1.5) \times 10^{-6}$. The retardation factor of this transition was estimated to be 550. α_π/α_K for the 1408-keV transition was determined to be 0.37 ± 0.07 in agreement with the theoretical ratio for an E1 multipolarity. The end-point energies of the two beta branches was determined as 727 ± 3 and 479 ± 10 keV, with intensities of $(1.1 \pm 0.2) \times 10^{-4}$ and $(2.9 \pm 0.5) \times 10^{-5}$, respectively, giving a Q-value of 1871 ± 3 keV. (auth)

10935 COMPARISON OF DR MODEL E_2 TRANSITION PROBABILITIES FROM THE 2^+ STATE OF THE γ-VIBRATIONAL BAND WITH EXPERIMENTAL VALUES. Augusthy, A.; Prasad, R.; Sehgal, M. L. (Aligarh Muslim Univ., India). Nuovo Cim.; 12A: No. 2, 341-8(21 Nov 1972).

The ratios of the E_2 transition probabilities from the 2^+ state of the γ-vibrational band to the 2^+ and 0^+ states of the ground-state rotational band in the rare-earth and actinide regions of the even-even nuclei are estimated using the asymmetric rotor model of Davydov and Rostovsky. The known experimental $B(E_2, 2^{+\prime} \rightarrow 2^+)/B(E_2, 2^{+\prime} \rightarrow 0^+)$ values for the above regions are compared with the theoretical estimates. It is observed that this model explains satisfactorily all the known experimental data except those of the platinum nuclei. An explanation for the disagreement in the platinum nuclei is given. (auth)

10936 E0 COMPONENT OF THE 689 keV $2_\beta \rightarrow 2_g$ TRANSITION IN ^{152}Sm. Stefansson, V.; Holmberg, L.; Baeverstam, U.; Becker, J.; Sergeev, V. (Univ. of Stockholm). Nucl. Phys.; A197: No. 1, 315-20(1972).

The electric monopole contribution to the 689-keV $2_\beta \rightarrow 2_g$ transition in ^{152}Sm is studied by measuring the 689K-122γ directional correlation. The result for the directional correlation coefficient is $a_2(K\gamma) = 0.10 \pm 0.05$. This value is used together with earlier electron and γ-ray intensity data to evaluate the E0/E2 electron amplitude and the M1 penetration parameter. The corresponding E0/E2 mixing ratio is compared with recent theoretical predictions. (auth)

10937 HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF ^{166}Tm. Aedelroth, K. E.; Ekstroem, C. (Chalmers Univ. of Tech., Goteborg). Nucl. Phys.; A198: No. 2, 380-90(1972).

The hyperfine structure of the $4f^{13}6s^2$, $^2F_{\frac{7}{2}}$ ground state of ^{166}Tm was studied using the atomic-beam magnetic resonance method. The hyperfine interaction constants and inferred nuclear moments are $|a| = 37.1$ (5) MHz, $|b| = 2935(40)$ MHz, $b/a < 0$, $\mu_I = 0.092(2)$ n.m., $Q = 1.85(15)$ b. The nuclear moments were calculated from the hyperfine interaction constants by using the $\langle r^{-3} \rangle$ value of the 4f electrons obtained from the measured magnetic dipole constant and moment of ^{169}Tm. The signs of the nuclear moments of ^{166}Tm are suggested by the positive value of Q/μ_I combined with the positive values of Q in this region of strong nuclear deformation. The magnetic dipole moment is corrected for diamagnetism; and the electric quadrupole moment, for the Sternheimer effect. The experimental results are compared with predictions made on the basis of the Nilsson model. (5 figures, 1 table). (auth)

10938 LOW-ENERGY γ-RAYS FROM RESONANCE NEUTRON CAPTURE IN $^{181}Ta(n,\gamma)^{182}Ta$. Riehs, P. (Reaktorzentrum, Seibersdorf, Austria); Axmann, H. P.; Murray, J.; Thomas, B. W. Nucl. Phys.; A198: No. 2, 430-8(1972).

The intensities of the γ transitions at 134, 173, 270, 296, 403, and 482 keV in ^{182}Ta were measured for about 30 neutron resonances in $^{181}Ta(n,\gamma)^{182}Ta$ up to 200 eV neutron energy by using a

Ge(Li) detector. The intensity ratio of the 270-keV transition to the Compton height of the γ spectrum indicates a grouping of the strengths according to the capture spins 3 and 4. Spin assignments were made for 25 resonances. From the decays of the 134- and 482-keV γ lines the half-life of the ^{181m}Ta isomer, $t_{½}$ = 18.5 ± 1.0 μs, was obtained. (auth)

10939 GAMMA–GAMMA ANGULAR CORRELATIONS IN THE DECAY OF ^{151}Nd. Begzhanov, R. B.; Kobilov, O. Sh.; Radzhapov, P. S.; Sabirov, Kh. S. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 1, 20-3(1971). (In Russian).

The angular correlations of cascade γ rays from ^{151}Pm were studied using a 96% enriched sample of ^{150}Nd which had been irradiated in a flux of 1.2×10^{12} neutrons cm^{-2} sec^{-1}. A graphical analysis was made of the cascades 1180–117, 1123–175, and 1784–117 keV, with certain pure E1 transitions taken into account. (2 figures, 1 table). (K.S.W.)

10940 FAST NEUTRON CAPTURE CROSS-SECTION MEASUREMENTS OF RARE-EARTH NUCLEI. Lepine, J. R. D. (Univ., Sao Paulo, Brazil); Douglas R. A.; Maia, H. A. Nucl. Phys.; A196: No. 1, 83-8(1972).

Measurements of neutron radiative-capture cross sections have been made using a Moxon–Rae detector and time-of-flight techniques. Cross-section ratios to In were determined for Sm, Eu, Gd, Tb, Dy, Ho, Er, Yb, Lu, and Ta for 30, 65, 165, and 300 keV neutron energies. (auth)

10941 ACCURATE LIFETIMES FOR THE 4^+ AND 6^+ ROTATIONAL STATES IN ^{156}Gd. Ward, D. (Chalk River Nuclear Labs., Ont.); Graham, R. L.; Geiger, J. S.; Rud, N.; Christy, A. Nucl. Phys.; A196: No. 1, 9-16(1972).

The lifetimes of the 4^+ and 6^+ levels of the ground-state rotational band in ^{156}Gd have been re-measured with higher precision. The states were populated by multiple Coulomb excitation with an 80 MeV ^{35}Cl beam. The Doppler-shift recoil distance method, in which γ-rays were detected in coincidence with back-scattered ions, was used to determine the lifetimes. The attenuation of the γ-ray angular distribution for the 4 → 2 transition in ^{156}Gd implanted in copper was measured with the result $G_2 = 0.89 \pm 0.05$ and $G_4 = 0.88 \pm 0.10$. The results for the lifetimes were $\tau(4^+)$ = 164.0 ± 3.0 ps, $\tau(6^+) = 22.8 \pm 0.55$ ps. These results are consistent with the predictions of the rigid-rotor model. (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 9266, 10431, 10795, 10825, 10856, 10857, 10863, 10901, 10929, 10930, 10935, and 11067–11069.

10942 (CONF-720701-(Absts.), pp 32-3) STUDY OF (n,γ) SPECTRA IN THE RESONANCES OF GOLD. Lottin, A.; Jain, A. (CEN de Saclay, Gif-sur-Yvette, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10943 (CONF-720701-(Absts.), pp 36-7) RESONANT ELASTIC SCATTERING OF γ RAYS AROUND 7 MeV. Lucas, R.; Babinet, R.; Fagot, J.; Nifenecker, H. (CEN de Saclay, Gif-sur-Yvette, France). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10944 (CONF-720701–(Absts.), pp 64-5) DOPPLER EFFECT STUDIES IN THE UNRESOLVED RESONANCE REGION OF GOLD. Schneider, E. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10945 (CONF-720701-(Absts.), pp 70-1) EXPERIMENTAL EVIDENCE FOR K = O EXCITED STATES IN ^{190}Os STUDIED BY THE (n$_{th}$,γ) REACTION. Heck, D. (Kernforschungszentrum, Karlsruhe, Ger.); Fanger, U.; Pepelnik, R.; Schmidt, H.; Stelzer, K. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10946 (CONF-720701–(Absts.), pp 164-5) ELASTIC SCATTERING OF 13.7 MeV NEUTRONS ON LEAD ISOTOPES. Belovitskii, G. E.; Voronkov, A. E.; Kolesnikova, L. N.; Frank, I. M.; Suchov, L. V. (Inst. for Nuclear Research, Moscow). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10947 (CONF-720701–(Absts.), pp 166-7) EXCITATION OF THE LOW-LYING OCTUPOLE 2.6 MeV STATE IN LEAD ISOTOPES BY 14 MeV NEUTRONS. Belovitzkii, G. E.; Kolesnikova, L. N.; Frank, I. M. (Inst. for Nuclear Research, Moscow). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10948 (CONF-720701–(Absts.), pp 194-5) INTERACTION OF 13.3 TO 17.1 MeV NEUTRONS WITH LEAD ISOTOPES. RESONANCE CHARACTER OF THE CROSS SECTION OF ^{207}Pb. Benetskii, B. A.; Nefedov, V. V.; Frank, I. M.; Shtranikh, I. V. (Inst. of Nuclear Research, Moscow). 1972. (In Russian).

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10949 (CONF-720701–(Absts.), pp 246) LOW ENERGY BREAK-UP OF POLARIZED DEUTERONS ON GOLD. Pope, C. (Univ. of Birmingham, Eng.); Blyth, C.; McKee, J. S. C.; Wolski, R. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10950 (CONF-720701-(Absts.), pp 264-5) NEUTRON AND γ-RAY YIELDS FROM THRESHOLD REGION IN ^{195}Pt. Lone, M. A.; Bartholomew, G. A.; Earle, E. D.; Ferguson, A. J. (Chalk River Nuclear Labs., Ont.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10951 (JINR–P6-6724) EXCITED STATES IN ^{212}Rn FROM THE EC-DECAY OF ^{212}Fr. Kharatym, Z.; Kempisty, T.; Korman, A.; Morek, T.; Peker, L. K.; Khoinatski, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The excited states in ^{212}Rn have been investigated in the electron-capture decay of ^{212}Fr produced in the reactions $^{nat.}$Pb(^{11}B,xn) and $^{nat.}$Tl(^{12}C,xn). On the basis of the measurements of gamma rays and gamma-gamma coincidences, the level scheme of ^{212}Rn is suggested. (auth)

10952 (JINR–P6-6767) EXCITED STATES OF ^{209}At. Vylov, Ts.; Golovkov, N. A.; Gromova, I. I.; Kolachkovskii, A.; Kuznetsova, M. Ya.; Norseev, Yu. V.; Chumin, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

The spectra of γ–γ coincidences are studied in the decay of ^{209}Rn. The decay scheme ^{209}Rn → ^{209}At is suggested. ^{209}At excited states with energies 408.3, 745.5, 794.8, 1081.0, 1092.7, 1097.4, 1394.0, 1953.0, 2135.5, 2414.7, and 2521.5 keV are introduced. The parts of population of ^{209}At levels in the decay of ^{209}Rn are introduced as well as corresponding values of lg ft. The positron intensity is determined to be $I_{\beta^+} = (3.6 \pm 0.5)\%$ per decay of ^{209}Rn. (auth)

10953 (LBL–1271) NUCLEAR ORIENTATION STUDIES ON SOME HIGH SPIN ISOMERS IN FERROMAGNETIC AND NON-FERROMAGNETIC LATTICES. Bacon, Frederick (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 152p. Dep. NTIS.

Thesis.

The methods of nuclear orientation and magnetic resonance on oriented nuclei have been applied to study the magnetic hyperfine interactions of some spin isomers in the $g_{9/2}$, $h_{11/2}$, and $i_{13/2}$ shell closure regions. It is demonstrated that from a nuclear orientation experiment alone only the magnetic hyperfine interaction constant can be determined unambiguously and that from the combined data of an orientation experiment and a magnetic resonance experiment on oriented nuclei the spin of the parent level can be determined. The nuclear magnetic dipole moments of the 12^- levels of ^{196}Au, ^{198}Au, and ^{200}Au were determined. From a magnetic resonance experiment on the oriented ground states of ^{196}Au and ^{198}Au the induced hyperfine fields in nickel for these nuclei were determined. The hyperfine anomalies between ^{196,198}Au and ^{197}Au were derived. A comparison of these derived anomalies and the one measured by the spin echo method is made and from this comparison a discussion of the non-contact contribution to the induced nickel field is presented. The spins, nuclear magnetic dipole moments and magnetic resonance frequencies were determined for ^{200m}Au, ^{195m}Pt, and ^{93m}Mo and E2/M1 mixing ratio for the 99 keV gamma of ^{195m}Pt was measured. A brute force polarization of ^{93m}Mo in niobium was demonstrated and the possibility of obtaining the single level hyperfine anomaly from a combined brute force and ferromagnetic polarization experiment is discussed. The magnetic hyperfine interaction constants for ^{101m}Rh in nickel and iron were determined and the magnetic resonance frequency for this isotope in nickel was observed. (auth)

10954 (LBL–1337) PARITY VIOLATION IN ^{203}Tl AND RESONANCE TRAPPING OF OPTICAL RADIATION. Simmons, M. K.

(California Univ., Berkeley. Lawrence Berkeley Lab.). 17 Nov 1972. Contract W-7405-eng-48. 134p. Dep. NTIS.

Thesis.

This thesis describes an investigation of the feasibility of observing a gamma-ray asymmetry from optically pumped ^{203}Hg. Such a parity-violating asymmetry results from the weak interaction between nucleons predicted by the current-current model of the weak interaction. The size of the predicted asymmetry is $\alpha \simeq 1 \times 10^{-4}$ for a perfectly polarized sample. We have performed optical pumping experiments on ^{201}Hg and ^{203}Hg to determine if sufficient polarization can be obtained in a high density sample for the predicted asymmetry to be observed. We find that resonance trapping of the optical pumping light causes depolarization in high density samples and prevents observation of the asymmetry. The phenomenon of resonance trapping was further investigated by observation of a two-photon cascade of calcium in an atomic beam. We observe trapping of the second photon of the cascade. Perturbation of the intermediate atomic state by an external magnetic field was observed by the effect on the angular correlation and linear polarization correlation of the two photons. These correlations were also affected by resonance trapping. (auth)

10955 SOME E2 RATES IN ^{211}At. Astner, G. (Forskningsinstitutet foer Atomfysik, Stockholm); Berg, V. Phys. Scr.; 5: No. 1-2, 55-7(1972).

The half-life of a $^3/_2$-level at 1116 keV excitation energy in ^{211}At has been measured to be 0.57 ± 0.04 nsec, using the delayed-coincidence technique. From a high-resolution study of parts of the conversion-electron spectrum it is shown that the depopulating transitions have the following multipolarities: 169 keV (E2 + (13 ± 2)% M1), 250 keV (E2) and 442 keV (E2). The reduced E2 transition probabilities are compared with theoretical predictions. The M1 rate corresponds to $^1/_6$ 400 Weisskopf units, in accordance with the interpretation of the two involved levels as essentially pure $\pi(h^2_{9/2})$ states. (auth)

10956 LEVEL STRUCTURE OF ^{206}Pb STUDIED FROM THE DECAY OF ^{206}Bi. Kanbe, M.; Fujioka, M.; Hisatake, K. (Tokyo Inst. of Tech.). Nucl. Phys.; A192: No. 1, 151-69(1972).

The decay of ^{206}Bi was studied with an iron-free $\pi\sqrt{2}$ β-spectrometer and a 35 cm^3 Ge(Li) detector. A total of 46 new transitions were found in ^{206}Pb from the internal conversion electron data. The multipolarities of 22 transitions in ^{206}Pb were unambiguously determined from L-subshell ratios, and those of another 24 transitions were obtained from the K-conversion coefficients by combining conversion and γ-ray intensities. The excited levels proposed by Alburger and Pryce are confirmed except for two levels; the 3124.7 keV level is omitted and the 2525.5 keV 3$^-$ level is shifted to 2647.50 keV. The present spin-parity assignments are in agreement with the previous ones, except for the 3016.14 keV level, which is assigned to be 5$^-$ instead of 6$^-$. In addition, 6 new levels were found. The energies in keV and spin-parities of these levels were 2826.00 4(5)$^-$, 2864.36, 2939.07 6$^-$, 3225.08 (5, 6, 7)$^-$, 3243.88 4$^-$, and 3562.51 5(4)$^-$. The levels of ^{206}Pb are interpreted in comparison with the shell-model calculations. (auth)

10957 OPTICAL-MODEL ANALYSIS OF THE ^{208}Pb(p,n)^{208}Bi(IAS) REACTION. Woods, T. J. (Univ. of Minnesota, Minneapolis); Whitten, C. A. Jr.; Igo, G. J. Nucl. Phys.; A198: No. 2, 542-60(1972).

The isobaric analog of the ^{208}Pb ground state was populated in the ^{208}Pb(p,n)^{208}Bi(IAS) reaction. The proton (β) decay of the IAS was used to obtain the IAS neutron angular distributions at proton bombarding energies of 24.8, 30.5, and 38.6 MeV by detecting the neutrons in coincidence with the β. DWBA analyses were performed for these data along with the data obtained at 50 MeV by the Rutherford Laboratory using a macroscopic interaction. Both complex and real form factors were found which adequately reproduce the data. These macroscopic form factors have rms radii more than 1 fm larger than the rms radius for the folded microscopic interaction. A possible interpretation for a complex form factor is presented. (auth)

10958 NUCLEAR DATA SHEETS FOR A = 212. Pancholi, S. C. (Univ. of Delhi); Martin, M. J. Nucl. Data, Sect. B; 8: No. 2, 165-91(Aug 1972).

A review of information available on level schemes and decay characteristics for all nuclei with mass number A = 212 is presented. Experimental data and their evaluation, adopted values, comparison with theory, and arguments for spin and parity assignments are given. Inconsistencies and discrepancies in the level schemes are discussed. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 9266, 9690, 10353, 10452, 10795, 10856, 10932, 10935, and 11069.

10959 (CONF-720701–(Absts.), pp 6-7) CONVERSION ELECTRONS FOLLOWING THERMAL NEUTRON CAPTURE IN ^{235}U. Fogelberg, B.; Baecklin, A. (Swedish Research Council's Lab., Studsvik). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10960 (CONF-720701–(Absts.), pp 10-11) LEVELS AND DECAY GAMMAS OF ^{232}Th AND ^{238}U. McMurray, W. R.; Van Heerden, I. J. (Southern Universities Nuclear Inst., Faure, S. Afr.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10961 (CONF-720701–(Absts.), pp 56-7) NEUTRON INDUCED REACTIONS ON ^{242}Pu BELOW 1 keV. Poortmans, F. (SCK-CEN, Mol, Belg.); Rohr, G.; Theobald, J. P.; Vanpraet, G.; Weigmann, H. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10962 (CONF-720701–(Absts.), pp 84-5) MEASUREMENT OF GAMMA-RAY SPECTRA FROM THERMAL NEUTRON INTERACTION WITH ^{235}U. Matussek, P.; Ottmar, H.; Piper, I.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10963 (CONF-720701–(Absts.), pp 86-7) STUDY OF ^{240}Pu BY THERMAL NEUTRON CAPTURE. Matussek, P.; Ottmar, H.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10964 (CONF-720701–(Absts.), pp 88-9) AVERAGE WIDTHS OF E1 AND M1 RADIATIVE TRANSITIONS FROM NEUTRON CAPTURE STATES IN ^{240}Pu. Ottmar, H.; Matussek, P.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10965 (CONF-720701–(Absts.), pp 90-1) OCTUPOLE BANDS IN ^{242}Pu. Matussek, P.; Ottmar, H.; Weitkamp, C.; Woda, H. (Kernforschungszentrum, Karlsruhe, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10966 (CONF-720701–(Absts.), pp 100-1) TOTAL CROSS SECTION OF ^{226}Ra BELOW 1 eV. Ceulemans, H.; Christiaen, H.; Goedeme, G. (SCK-CEN, Mol, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10967 (CONF-720701–(Absts.), pp 172-3) INELASTIC NEUTRON SCATTERING FROM ^{238}U. Armitage, B. H.; Rose, J. L.; Spencer, W. 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10968 (CONF-720701–(Absts.), pp 184-5) INTERACTION OF FAST NEUTRONS WITH ^{235}U. Knitter, H.-H.; Islam, M. M.; Coppola, M. (Central Bureau for Nuclear Measurements, Geel, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10969 (CONF-720701–(Absts.), pp 200-1) NEUTRON WIDTHS OF ^{238}U FROM 140 eV TO 770 eV. Carraro, G.; Brusegan, A. (CBNM–Euratom, Geel, Belg.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10970 (CONF-720701–(Absts.), pp 224-5) NEUTRON TOTAL, CAPTURE, AND FISSION CROSS SECTION MEASUREMENT ON ^{240}Pu. Hockenbury, R. W.; Moyer, W. R.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, NY). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10971 (FEI-274) ABSOLUTE MEASUREMENTS OF THE VALUE OF α FOR ^{235}U AND ^{239}Pu IN THE REGION OF NEUTRON ENERGY 10 keV TO 1 MeV. Kononov, V. N.; Poletaev, E. D.; Prokopets, Yu. S.; Metlev, A. A.; Stavisskii, Yu. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 32p. (In Russian). Dep. NTIS (U.S. Sales Only).

The cross section ratios for radioactive capture and fission of ^{235}U and ^{239}Pu are reported in the neutron energy region 10 keV to 1 MeV. (L.T.W.)

10972 (FEI-285) TECHNIQUE OF MEASURING THE RATIO OF RADIATIVE CAPTURE CROSS SECTION TO FISSION CROSS SECTION. Dvukhsherstnov, V. G.; Kazanskii, Yu. A.; Plaksin, E. A.; Furmanov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

A technique is described for measuring the ratio of the radiative capture cross section to the fission cross section (alpha) using a single-crystal scintillation spectrometer with divided channels for counting neutrons and gamma rays. The accuracy and corrections applicable to the measurement of "alpha" by the given method are discussed. Values of "alpha" for ^{235}U and ^{239}Pu were measured with 2 and 24.5 keV neutrons, obtained by passing the neutron beam of a thermal reactor through filters of Sc and Fe. (tr-auth)

10973 (GULF-GA-B-12071) REVIEW OF FISSION PRODUCT YIELDS AND CROSS SECTIONS. Mathews, D. R.; McGehee, B. G. (Gulf General Atomic Co., San Diego, Calif.). Sep 1971. Contract AT(04-3)-167. 11p. Dep. NTIS.

A survey of fission product yields from thermal neutron induced fission of U-233, U-235, Pu-239 and Pu-241 as well as fast neutron fission of Th-232 and U-238 has been made. Recommended yields, half-lives, 2200 m/sec capture cross sections and infinite dilution resonance integrals are compared with the data presently used by the HTGR design group. (auth)

10974 (IA-1243) NUCLEAR DATA EVALUATION FOR ^{240}Pu. Caner, M.; Yiftah, S. (Israel Atomic Energy Commission, Tel Aviv). May 1972. 108p. Dep. NTIS (U. S. Sales Only).

An evaluation was done from 10^{-3} eV to 15×10^6 of the following ^{240}Pu neutron cross sections: total, elastic, radiative capture, fission, total inelastic, partial inelastic, (n,2n), (n,3n), and differential elastic. Also the number of prompt neutrons per neutron-induced fission and the average elastic scattering cosine in the lab system were evaluated. The data are presented in graphical and tabular form. The experimental data were supplemented by optical model and statistical theory code calculations and by systematics. (auth)

10975 (INDC(CCP)-26/U) EVALUATION OF THE ^{235}U FISSION CROSS SECTION. Konshin, V. A.; Nikolaev, M. N. (International Nuclear Data Committee). Sep 1972. 26p. Dep. NTIS (U. S. Sales Only).

The ^{235}U fission cross section is evaluated in the energy range 1 keV to 15 MeV. The effects of resonance self-shielding were not included. (J.W.R.)

10976 (JINR-P15-6730) PROMPT NEUTRONS FOR SPONTANEOUS FISSION OF ^{246}Cf. Dakovskii, M.; Lazarev, Yu. A.; Oganesyan, Yu. Ts.; Buklanov, G. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The multiplicity distribution as well as the average number of prompt neutrons for spontaneous fission of ^{246}Cf ($\tau_{\frac{1}{2}} = 35.7$ h) have been measured: $\bar{\nu} = 3.14 \pm 0.09$, on the basis of $\bar{\nu} = 2.69 \pm 0.01$ for ^{244}Cm. Neutron detector consisted of 36 ^3He-filled proportional counters embedded in plexiglas. The efficiency of detection was 48.2%. ^{246}Cf was synthesized in the reaction ^{238}U (^{12}C, 4n) using carbon beam from the U-300 cyclotron of Laboratory of Nuclear Reactions, JINR. (auth)

10977 (LA-DC-72-1243) LASL STATUS REPORT TO THE U. S. NUCLEAR DATA COMMITTEE. (Los Alamos Scientific Lab., N. Mex.). [nd]. 17p. (CONF-721053-1). Dep. NTIS.

From U. S. Nuclear Data Committee meeting; Washington, D. C. (24 Oct 1972).

The research covers neutron cross sections by time of flight, fast neutron studies, thermal neutron capture gamma-ray studies, fission studies, evaluation, and nuclear research related to safeguards. Some previously unreported data on prompt neutrons from ^{257}Fm spontaneous fission, fission neutron spectra of ^{238}U, ^{235}U, and ^{239}Pu at 1.85 MeV excitation, neutron source reactions T(p,n) and ^9Be(d,n), and gamma spectra from ^{240}Pu(n,γ) are presented. (J.W.R.)

10978 (LUNP-7213) FISSION OF URANIUM BY 400 TO 580 MeV PROTONS. Schroeder, Bent (Lund Univ. (Sweden). Dept. of Physics). Nov 1972. 36p. Dep. NTIS (U. S. Sales Only).

The forward-to-backward ratio of the activities of the fission products of uranium induced by protons of energies 400, 450, 525, and 580 MeV have been determined by the direct gamma-ray spectroscopy method. In the analysis, which was made with respect to the most stable charge number in a given mass chain, it turned out that the F/B and $\eta_{||}$ values at the location of the stability valley are constants, 1.3 and 0.056 respectively. (auth)

Nuclear Theory

Refer also to abstracts 10545, 10598, 10795, and 10852.

10979 (BNL-tr-504) DETERMINATION OF THE DIFFUSENESS OF THE NUCLEAR SURFACE IN THE INTRANUCLEAR CASCADE MODEL. Barashenkov, V. S.; Gudima, K. K.; Gereghi, F. G.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-6053. 7p. Dep. NTIS.

A method for the determination of the coordinates and momenta of all the intranuclear nucleons in the intranuclear cascade model without breaking the nucleus down into zones is proposed. (J.W.R.)

10980 (BNL-tr-505) HAUSER-FESHBACH METHOD FOR MANY-PARTICLE NUCLEAR REACTIONS. Savel'ev, A. E. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Yadern. Fiz.; 15: No. 2, 272-7(1972). 11p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 34854. (TSS)

10981 (CEA-N-1564) COMPUTER PROGRAM FOR ANALYSIS OF THE CROSS SECTIONS OF FISSILE NUCLEI IN THE RESONANCE REGION USING A MULTILEVEL FORMALISM. Derrien, H.; Alix, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

A program for the analysis of the total and fission cross sections of fissile nuclei in the neutron resonance region is presented. The theoretical cross sections are calculated using the Reich-Moore formalism (deduced from the R matrix theory of nuclear reactions). It is possible to take into consideration two fission channels per spin state of the compound nucleus obtained by s-wave neutron capture. The theoretical values are fitted to the experimental values using a least square method. Such a method can be applied to both the total and fission cross sections. The program is written for the Saclay CDC-6600 computer. (France)

10982 (CONF-720701-(Absts.), pp 2-3) R-MATRIX ANALYSIS WITH A DIFFUSE-EDGE POTENTIAL FOR $^{16}O + n$ DATA. Johnson, C. H.; Fowler, J. L.; Freezel, R. M. (Oak Ridge National Lab., Tenn.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10983 (CONF-720701-(Absts.), pp 18-19) TRIANGULAR DIAGRAM DOMINANCE IN 14 MeV (n,α) REACTIONS ON DEFORMED RARE-EARTH NUCLEI. Glowacka, L.; Jaskola, M.; Kozlowski, M.; Osakiewicz, W.; Turkiewicz, J.; Zemlo, L. (Inst. of Nuclear Research, Warsaw). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10984 (CONF-720701-(Absts.), pp 30-1) SHELL-MODEL NUCLEAR LEVEL DENSITIES WITH APPLICATIONS IN NEUTRON CROSS SECTION CALCULATIONS. Eriksson, John (Neutron Physics Lab., Studsvik, Sweden). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10985 (CONF-720701-(Absts.), pp 42-3) CIRCULAR POLARIZATION OF NEUTRON CAPTURE GAMMA RADIATION. Abrahams, K. (Reactor Centrum Nederland, Petten). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10986 (CONF-720701-(Absts.), pp 48-9) COREPOLARIZATION KNOCK OUT EXCHANGE MECHANISM AND (p,n) REACTIONS. Geramb, H. V.; Sprickmann, R. (Kernforschungsanlage, Juelich, Ger.). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10987 (CONF-720701-(Absts.), pp 76-7) AMBIGUITIES OF R-MATRIX PARAMETERS IN THE ANALYSIS OF LOW-ENERGY

NEUTRON CROSS SECTIONS. Adler, D. B.; Adler, F. T. (Univ. of Illinois, Urbana). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10988 (CONF-720701-(Absts.), pp 78-9) NEUTRON STRIPPING AND OFF-SHELL SCATTERING. Fuchs, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Homeyer, H.; Lipperheide, R.; Moehring, K.; Oeschler, H. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10989 (CONF-720701-(Absts.), pp 80-1) SURVEY OF THE STATISTICAL NEUTRON DECAY OF ISOBARIC ANALOGUE RESONANCES. Buechs, K.-D.; Finckh, E.; Jahnke, U.; Pietrzyk, P.; Schreiber, B. (Hahn-Meitner-Institut, Berlin). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10990 (CONF-720701-(Absts.), pp 126-7) THEORETICAL INTERPRETATION OF THE NUCLEAR STRUCTURE OF THE N = 83 NUCLEI. Vanden Berghe, G. (State Univ., Ghent). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10991 (CONF-720701-(Absts.), pp 136-7) P-WAVE NEUTRON STRENGTH FUNCTION NEAR MASS 55 AND 160. Turinsky, P. J.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, NY). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10992 (CONF-720701-(Absts.), pp 138-9) OPTICAL MODEL FOR LOW ENERGY ALPHA PARTICLES AND (n,α) REACTIONS. Furman, V. I.; Popov, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10993 (CONF-720701-(Absts.), pp 142-3) EVIDENCE FOR COMPLEX LANE POTENTIAL FROM STRENGTH FUNCTION MEASUREMENTS. Newstead, C. M. (Kernforschungszentrum, Karlsruhe, Ger.); Delaroche, J. P. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10994 (CONF-720701-(Absts.), pp 144-5) NEUTRON–NUCLEUS SPIN–SPIN INTERACTION AND NEUTRON STRENGTH FUNCTIONS. Newstead, C. M. (Kernforschungszentrum, Karlsruhe, Ger.); Delaroche, J. P.; Cauvin, B. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10995 (CONF-720701-(Absts.), pp 146-7) DEEP S- AND P-WAVE STRENGTH FUNCTION MINIMA AND THE ABSORPTIVE POTENTIAL. Newstead, C. M. (Kernforschungszentrum, Karlsruhe, Ger.); Delaroche, J. P. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10996 (CONF-720701-(Absts.), pp 152-3) WELL-DEFINED QUANTITIES IN OPTICAL MODEL FORMULATION. Sood, P. C.; Agrawal, D. C. (Banaras Hindu Univ., India). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10997 (CONF-720701-(Absts.), pp 154-5) GENERALIZED OPTICAL MODEL POTENTIAL DERIVED FROM OPTICAL PARAMETERS OF A SYSTEMATIC FAST NEUTRON ELASTIC SCATTERING STUDY. Holmqvist, B.; Wiedling, T. (Neutron Physics Lab., Studsvik, Sweden). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10998 (CONF-720701-(Absts.), pp 156-7) SEARCH PROCEDURE IN OPTICAL MODEL CALCULATIONS. Holmqvist, B.; Wiedling, T. (Neutron Physics Lab., Studsvik, Sweden). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

10999 (CONF-720701-(Absts.), pp 158-9) LEVEL WIDTH AND RESONANCE INTERFERENCE EFFECTS IN FAST NEUTRON INELASTIC SCATTERING. Almen, E.; Holmqvist, B.; Wiedling, T. (Neutron Physics Lab., Studsvik, Sweden). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11000 (CONF-720701-(Absts.), pp 160-1) DESCRIPTION OF FAST NEUTRON CROSS SECTIONS BY A SEMI-CLASSICAL MODEL. Angeli, I.; Csikai, J.; Dajko, G. (Kossuth Univ., Debrecen, Hungary). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11001 (CONF-720701-(Absts.), pp 162-3) SINGLE NEUTRON STATES IN DEFORMED NUCLEI. Andersen, B. L. (Niels Bohr Inst., Copenhagen). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11002 (CONF-720701-(Absts.), pp 168-9) ANALYSIS OF (n,α) AND (p,α) SPECTRA BY THE PRE-EQUILIBRIUM MODEL. Caplar, R. (Inst. Rudjer Boskovic, Zagreb); Kulisic, P. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11003 (CONF-720701-(Absts.), pp 170-1) OPTICAL MODEL ANALYSES OF NEUTRON POLARIZATIONS AT 3.2 MeV. Zijp, E.; Jonker, C. C. (Vrije Univ., Amsterdam). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11004 (CONF-720701-(Absts.), pp 180-1) HIGHER ORDER SPACING DISTRIBUTIONS IN ^{239}Pu AND ISOTOPES OF NEODYMIUM. Jain, A.; Blons, J.; Tellier, H. (CEN de Saclay, Gif-sur-Yvette, France). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11005 (CONF-720701-(Absts.), pp 182-3) SINGLE PARTICLE LEVEL DENSITIES OF SUPERHEAVY NUCLEI. Ghosh, S. K.; Chatterjee, Aparesh (Saha Inst. of Nuclear Physics, Calcutta). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11006 (CONF-720701-(Absts.), pp 186-7) SEARCH OF CORRELATIONS FOR EQUIDISTANT NEUTRON RESONANCES OF SOME NUCLEI. Balabanov, N. P.; Mateeva, A.; Popov, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11007 (CONF-720701-(Absts.), pp 192-3) ROLE OF THE γ-DECAY OF UNBOUND NUCLEAR STATES IN THE NUCLEON INDUCED REACTIONS. Decowski, P.; Grochulski, W.; Marcinkowski, A. (Inst. of Nuclear Research, Warsaw). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11008 (CONF-720701-(Absts.), pp 196-7) EVALUATION OF (n,2n) CROSS SECTIONS AT 14.7 MeV. Body, Z. T.; Csikai, J. (Kossuth Univ., Debrecen, Hungary). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11009 (CONF-720701-(Absts.), pp 198-9) POSSIBLE IDENTIFICATION OF $5/2^-$ ^{29}Si DOORWAY STATES OR $1f_{5/2}$ SINGLE PARTICLE FRAGMENTS? Choi, B.-H. (Univ. of North Carolina, Chapel Hill); Divadeenam, M.; Pineo, W. F. E.; Newson, H. W. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11010 (CONF-720701-(Absts.), pp 202-3) CALCULATED SPECTRA OF NEUTRONS FROM (n,n') AND (n,2n) REACTIONS. Kluge, G.; Jeki, L.; Lajtai, A. (Central Research Inst. for Physics, Budapest). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11011 (CONF-720701-(Absts.), pp 206-7) METHOD FOR THE STATISTICAL ANALYSIS OF THE CROSS SECTIONS OF FISSILE NUCLEI. Garrison, J. D. (California State Univ., San Diego). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11012 (CONF-720701-(Absts.), pp 212-13) STRUCTURE OF NEUTRON RESONANCES. Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11013 (CONF-720701-(Absts.), pp 218-19) TOTAL RADIATION WIDTHS AND NON-STATISTICAL EFFECTS IN NEUTRON RESONANCE CAPTURE. Beer, H. (Kernforschungszentrum, Karlsruhe, Ger.); Spencer, R. R.; Ernst, A.; Froehner, F. H. 1972.
From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11014 (CONF-720701-(Absts.), pp 234-5) CORRELATION BETWEEN THE (d,p) AND (n,γ) STRENGTH IN THE MASS REGION A = 40 TO 70. Kopecky, J.; Stecher-Rasmussen, F. (Reactor Centrum Nederland, Petten). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11015 (CONF-720701-(Absts.), pp 240-1) NEUTRON CAPTURE MECHANISM. COMPOUND NUCLEUS EXIT STATES MODEL. Brzosko, J. S.; Piotrowski, J.; Soltan, A. Jr.; Szeflinski, Z. (Univ., Warsaw). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11016 (CONF-720701-(Absts.), pp 242-3) NON-STATISTICAL EFFECTS IN INELASTIC SCATTERING OF LOW-ENERGY NEUTRONS. Konobeevskii, E. S.; Musaelyan, R. M.; Popov, V. I.; Surkova, I. V. (Inst. of Nuclear Research, Moscow). 1972. (In Russian).

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11017 (CONF-720701-(Absts.), pp 248-9) NON-STATISTICAL BEHAVIORS IN THE DISTRIBUTION OF NEUTRON RESONANCE LEVELS. Ideno, K. (Japan Atomic Energy Research Inst., Tokai). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11018 (CONF-720701-(Absts.), pp 250-1) MASS DEPENDENCE OF DIRECT-SEMI-DIRECT THEORY CALCULATIONS FOR THE 14 MeV NEUTRON RADIATIVE CAPTURE. Potokar, M.; Cvelbar, F.; Budnar, M.; Likar, A. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11019 (CONF-720701-(Absts.), pp 256-7) CALCULATION OF THE DENSITY AND THE STRUCTURE OF NEUTRON RESONANCES IN ^{239}U. Malov, L. A.; Soloviev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11020 (CONF-720701-(Absts.), pp 268-9) GROUPINGS OF LEVEL SPACING IN NEUTRON RESONANCES. Belyaev, F. N.; Borovlev, S. P. (Inst. of Theoretical and Experimental Physics, Moscow). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11021 (CONF-720701-(Absts.), pp 270-1) DEVIATIONS FROM THE STATISTICAL DISTRIBUTIONS OF LEVEL SPACINGS. Sukhoruchkin, S. I. (Inst. of Theoretical and Experimental Physics, Moscow). 1972.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

11022 (DNPL/R-21) OPEN PROBLEMS IN NUCLEAR STRUCTURE. Proceedings of the Daresbury Study Weekend No. 5, 12-14 May 1972. Irvine, J. M.; Mani, G. S.; Pucknell, V. F. E. (eds.) (Daresbury Nuclear Physics Lab. (England)). 213p. (CONF-720563).

Eight papers were presented, abstracts for all of which have been prepared. Discussions and a closing address are included. (UK)

For abstracts of individual papers see: 11023–11030.

11023 (DNPL/R-21, pp 1-12) SOME OPEN TOPICS IN NUCLEAR STRUCTURE. Willmott, J. C. (Univ. of Manchester, Eng.).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

Reasons for studying the structure of the nucleus are outlined. Very little is known about the ways in which a quantum mechanical many-body system behaves and why, and it is through a study of nuclear structure that the best hope lies in achieving an understanding of the many facets. Reference is made to the proposed new machine at Daresbury, which would provide a flexible beam of heavy ions. Reference is also made to fundamental calculations, and to the various possibilities that occur as the energy of a heavy ion beam is raised. An area of complete ignorance is Coulomb fission. High spin states in stable rotors need looking at, and also sudden changes in the moment of inertia. The use of (α,xn) and (^{12}C,4n) reactions is discussed. Grazing reactions also receive attention, and may lead to all sorts of strange nuclei, ^{24}O and ^{25}F have been observed from the bombardment of ^{232}Th by ^{22}Ne, and in the production of ^{24}O there is a loss of two protons and a gain of six neutrons. The diagram of predicted particle stable nuclei with regions where rotational spectra might occur is shown—no new regions have yet been discovered. The production of neutron-rich nuclei, which are predicted to exist in far greater numbers than proton-rich nuclei, is discussed. Finally the difficulty in interpreting and understanding data on odd-odd nuclei is emphasized. (UK)

11024 (DNPL/R-21, pp 13-42) CURRENT STATUS OF THE MESON THEORY OF NUCLEAR FORCES. Brown, G. E. (State Univ. of New York, Stony Brook); Jackson, A. D.

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

The nucleon-nucleon interaction can be divided into three regions. The long range part of the interaction (I) is determined by the one-pion exchange term, as is well known. The present paper is concerned with giving a detailed description of the intermediate range (II) in terms of two-pion exchange, and a possible description of the inner region (III) is also discussed. Because of the spin and isospin dependence of the one-pion exchange term its contribution to nuclear binding energies will tend to average out when sums are taken over spin and isospin variables, and it is clear that region I will not contribute sufficiently to bind nuclei. Region III gives repulsion, and hence most of the binding comes from region II. The repulsive inner region is thought to arise mainly from the exchange of massive vector mesons. The neutral vector meson (W) behaves like a heavy photon, and its exchange will provide a repulsion between all pairs of baryons. The postulation of short range repulsive potentials from vector meson exchanges in applying the one-boron exchange process is discussed, together with the use of "cut-offs." An alternative approach is described in which is summed a class of Feynman diagrams thought to give the leading behaviour of the matrix elements for large momentum transfers between two interacting nucleons. Headings are as follows: the two-pion exchange region; treatment of the short-range interaction (Eikonal techniques; nucleon electromagnetic form factor; and nucleon-nucleon scattering). (UK)

11025 (DNPL/R-21, pp 43-67) EFFECTIVE INTERACTION FOR USE IN NUCLEAR STRUCTURE CALCULATIONS. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

Progress of work begun several years ago on deducing potential matrix elements from phase shifts and applying them to calculations of nuclear structure in a shell-model framework is discussed, and some comments are made on perturbation theory. With regard to the term "effective interaction" it is stated that it can be easily misunderstood. Starting from the true interaction an effective interaction may be formally defined by projecting from the infinite Hilbert space on to a small finite space of the lowest shell-model configuration. This effective interaction is generally a many-body operator and will differ from one shell to another. If such an interaction could be deduced the calculation of energy levels would be an easy problem, but the calculation of such an effective interaction is very difficult and requires a solution of the many-body problem. In practice calculations of effective interactions use perturbation theory and questions of convergence arise; the calculation is almost identical with a perturbation calculation of energies. An effective interaction must be carefully defined both with regard to the shell-model space in which it is defined and the number of terms in the perturbation series taken into account. (UK)

11026 (DNPL/R-21, pp 69-92) REALISTIC INTERACTIONS IN NUCLEAR STRUCTURE CALCULATIONS. Irvine, J. M. (Univ. of Manchester, Eng.).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

This paper follows on from that of Brown who described some recent attempts to build an interaction from meson field theory and that of Elliott who discussed how effective interactions may be extracted directly from scattering data. Assuming that these attempts to describe N-N interaction are successful the present author considers the problem of how the results may be used to calculate some nuclear structure properties, and high-lights some of the major difficulties involved. (UK)

11027 (DNPL/R-21, pp 93-103) LARGE-SCALE SHELL-MODEL CALCULATIONS IN THE sd-SHELL. Whitehead, R. R. (Univ. of Glasgow).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

The task of doing shell-model calculations is discussed. Such calculations are conceptually simple—just evaluate the Hamiltonian matrix and diagonalize it; but if there are many particles or single particle orbitals the number of states becomes so large

that the calculation becomes too big to handle, and further approximations in the form of basis truncations must be made. If such truncations are made, however, it becomes difficult to know whether the inevitable discrepancies between calculation and observation are the fault of the interaction being used, or of the truncations. It is therefore desirable to be able to do calculations that are as free of approximation as possible, in order to try to separate the effects of the force from those of the basis, and a method of doing shell-model calculations has been developed that, in many cases, allows very large calculations to be done with removal of at least some of the uncertainty. This method is rather unlike standard shell-model techniques, and details are given. All the group-theoretic formalism of the shell-model are done away with, including angular momentum, and the work is done with Slater determinants, or more precisely, states in an occupation number representation. A large number of states are, however, involved—many more than if an angular momentum coupled representation is used; for example, in a calculation for ^{28}Si with 12 particles distributed in all ways throughout the sd-shell, there are about 93,000 states to be considered, too many for any computer using standard diagonalisation techniques, but this is overcome by using an algorithm for tri-diagonalizing a matrix. This allows combination of calculation of the matrix and its tri-diagonalization into one process. A calculation for ^{24}Mg is given. It is stated that use may be made of time-reversal and neutron-proton symmetry to reduce the size of some calculations. Comparisons of the shell-model results with experiment are discussed. It remains to be seen whether many-body theory can provide a detailed connection between the G-matrix and the truncated space effective interaction. (UK)

11028 (DNPL/R-21, pp 105-20) STRUCTURE CALCULATIONS IN LIGHT NUCLEI. Mani, G. S. (Univ. of Manchester, Eng.).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

It is stated that any shell-model calculations on nuclei involves the choice of a suitably truncated model space and the construction of an effective interaction for use within such a model space. The truncation is usually dictated by computer size and time available and also takes into account the symmetry problems expected in the calculation. The basis states in the space are usually chosen to be harmonic oscillator functions. with regard to constructing an effective interaction from the free nucleon-nucleon interaction suitable for the model space chosen, two problems arise. Firstly the nucleon-nucleon interaction has an extremely strong repulsive core that produces short range correlations. Such correlations are related to the very high momentum component of the wave function and the interaction has to be renormalized with respect to scattering to such very high momentum states. The second problem relates to long range correlations that arise from scattering to states outside the model space due to the long range attractive part of the interaction. The calculations presented are mainly concerned with the second problem. Binding calculations are described for ^{3}He, ^{4}He, and ^{6}Li. It seems from these calculations that it is necessary to include two major shells above the space in which the particles are distributed in a simple shell model picture before a reasonable energy convergence is obtained. A question that arises is, when does the α-particle become a core as one proceeds along the p-shell nuclei; such calculations have been made and it is found that by the time ^{12}C is reached the α-core is stabilized. Results indicate (i) the importance of the 2p-2h correlations in light nuclei, (ii) the eventual formation of a core and hence a slow appearance of the shell model, and (iii) a rapid convergence in energy in a small model space. (UK)

11029 (DNPL/R-21, pp 121-44) PROBLEMS OF ELECTRODYNAMICS OF STRONG FIELDS AND THEIR POSSIBLE TESTS IN HEAVY ION COLLISIONS. Mueller, B.; Rafelski, J.; Greiner, W. (Univ., Frankfurt am Main).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

It is stated that the discrete energy eigenvalues for an electron bound to a nucleus, as obtained from the Dirac equation, lie between m_0c^2 and $-m_0c^2$, where m_0 is the electron mass. In the case of a point nucleus the energy eigenvalues are given by the Sommerfeld find structure formula, and the values for the Is state become imaginary when the nuclear charge Z becomes >137. This problem may be circumvented by attributing finite dimensions to the nucleus, and the Is energy eigenvalue becomes equal to $-m_0c^2$, where the negative energy continuum begins, for $Z_{critical} \approx 169$. The value of Z_{cr} depends on many assumptions concerning the potential in the vicinity of the nucleus. Interpretation has been uncertain when the Is eigenvalue becomes equal to $-m_0c^2$, and at this point the single-particle theory appears to break down; an interpretation advanced is that electron-positron pairs are created spontaneously. In this connection enough information could possibly be obtained from the collision of heavy ions, such as Pb on Pb or Cf on Cf, etc. to decide whether this interpretation is correct. During the heavy ion collisions the energy eigenvalue of inner electrons will be steadily decreased, with increasing binding, until at a critical distance R_{cr} it becomes equal to $-m_0c^2$. When R_{cr} is passed it would be expected that the eigenvalue would "dive" into the negative energy continuum. Search for a reliable method of calculating this "diving" led to a consideration of the extent to which it is analogous to the process of autoionization. It was found that the bound level "dives" into the negative energy continuum for $Z > Z_{cr}$. The position corresponds closely to time dependent perturbation theory. Applications to superheavy elements are also discussed. Underlying all the calculations is the assumption that the movement of the nuclei is adiabatic compared to that of the electrons, and that the inner shells are filled with electrons. (UK)

11030 (DNPL/R-21, pp 145-98) PRESENT STATUS IN SUPER-HEAVY ELEMENT CALCULATIONS. Nilsson, S. G.; Damgaard, J. (Lund Inst. of Tech., Sweden).

From Proceedings on open problems in nuclear structure; Daresbury, England (12 May 1972).

The subject is dealt with under the following main headings the two-body force approach; the microscopic-macroscopic approach; one single particle potential; other potentials; results of calculations using ϵ, ϵ_4 shapes; asymmetric degrees of freedom; axial symmetry; barrier characteristics; superheavy element half-lives; and termination of the r-process path. Conclusions reached are as follows: the prediction of the half-lives of superheavy elements rests at present first on the applicability of the microscopic-macroscopic approach, and the shell correction method appears reasonably well founded. Results are borne out by alternative methods that are being explored. Secondly, it rests on a detailed knowledge of the liquid drop constants and the applicability of these in a new mass region. Thirdly, the predictions depend on the availability of a single-particle model whose parameters may be reliably extrapolated to a new mass region. The magnitude of the Z = 114 and N = 184 shell gaps are somewhat differently predicted by the different single-particle models in use, and as a consequence the predicted fission and α half-lives differ by several orders of magnitude. The details of the superheavy "island" are thus subject to considerable doubt. (UK)

11031 (IAE-2119) CORRELATION EFFECTS FOR INTERNAL CONVERSION ELECTRONS FOLLOWING β DECAY OF NUCLEI. Lyul'ka, V. A. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Correlation effects for internal conversion electrons which accompanied β-decay of nuclei of the first order of forbiddenness were examined. Expressions were obtained for coefficients which determined correlation effects for cascade decays of this type of nucleus. These coefficients were calculated for U-A theory of weak interactions and all nuclear matrix elements were evaluated which were essential for each given order of forbiddenness. Electron functions and Coulomb phases determined some combinations of these values analogous to those employed by M. Morita and R. Morita (1958). Formulas were obtained for angular and polarized correlations of β-electrons and internal conversion electrons for a given order of forbiddenness. A formula for the correlation of electron polarization was considered. Correlation effects were discussed in detail in the case of unique β-transitions of nuclei. The character of these effects was independent of the order of forbiddenness. (tr-auth)

11032 (JINR-P4-6631) ON MULTIQUASIPARTICLE COMPONENTS OF NEUTRON RESONANCE WAVE FUNCTIONS. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 10p. (In Russian). Dep. NTIS (U. S. Sales Only).

A problem is considered concerning the values of multiquasiparticle components for highly excited state wave functions. Two possibilities for the wave functions of neutron resonances are considered: the first one—that all the components are small, and the second one—there are large multiquasiparticle components. The possibility of existing of large multiquasiparticle components is demonstrated by the model taking account of quasiparticle-phonon interactions. The means of experimental display of large multiquasiparticle components of neutron resonance wave functions are considered. (auth)

11033 (KHFTI-87-5) MULTIPOLE ANALYSIS OF THE REACTIONS $^{4}He(\gamma,p)^{3}H$ AND $^{4}He(\gamma,n)^{3}He$. Gur'ev, V. N. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 23p. (In Russian). Dep. NTIS (U.S. Sales Only).

Model-independent multipole analyses were made for the reactions $^4He(\gamma,p)^3H$ and $^4He(\gamma,n)^3He$ with parameterized multipole amplitude in an approximation of two-part unitarity. Expressions for $d\sigma/d\Omega$ and $d\sigma/d\Omega$ P are given, where P is the polarization of the final particle, through a bilinear combination of multipole amplitudes with a total momentum of $\tau = 1.2$. The consistency of the data on the phase analysis of nucleon scattering by three-particle nuclei with the experimental evaluation of the phase difference E1 and E2 amplitudes was investigated for the reaction $^4He(\gamma,p)^3H$. The coefficient of asymmetry was examined for the angular distribution of photoneutrons for 28 MeV photons. The criticality evaluation was applied to the ratio of quadrupole cross sections of the reactions. The ratio $\sigma(\gamma,p) : \sigma(\gamma,n)$ was evaluated at the maximum of a giant dipole resonance. The behavior of proton recoil polarization was investigated at 90° for $E_\gamma \rightleftharpoons 23$ to 28 MeV. (tr-auth)

11034 (LUNP–7212) COMPILATION AND ANALYSIS OF INTERMEDIATE- AND HIGH-ENERGY PHOTON AND ELECTRON INDUCED SPALLATION YIELDS. Jonsson, G. G.; Lindgren, K. (Lund Inst. of Tech. (Sweden). Dept. of Nuclear Physics). Oct 1972. 31p. Dep. NTIS (U. S. Sales Only).

Available intermediate- and high-energy photon and electron induced spallation yields have been compiled and analyzed with the five-parameter formulas given by Rudstam. The mass and energy dependence of the parameters are discussed. With appropriate parameters the CDMD formula is then used to estimate spallation yields and cross sections. (auth) (Sweden)

11035 (LYCEN–7224) MUON ABSORPTION BY NUCLEI WITH EXTRA NEUTRONS. Joseph, J. (Lyon Univ. (France). Institut de Physique Nucleaire); Ledoyen, F. (Laval Univ. (Quebec) ; Goulard, B. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Apr 1972. 37p. Dep. NTIS (U. S. Sales Only).

Muon absorption was investigated for neutron rich nuclei in order to establish whether the results obtained with N = Z nuclei are valid for nuclei with N > Z. Several nuclei were taken as examples, particular emphasis being given to the ^{88}Sr nucleus. (France)

11036 (LYCEN–7247) INVESTIGATION OF THE n–p FSI IN THE DEUTERON BREAK UP REACTION. Chemarin, M. (Lyon Univ. (France). Institut de Physique Nucleaire). 18 Jul 1972. 4p. Dep. NTIS (U. S. Sales Only).

The final state n–p interaction in the p + d reaction at 9.1-MeV (9 c.m. system) was studied in the framework of a sequential model in which the break-up of the deuteron occurs in two stages. The final-state interaction was first studied as a function of the p–n pair production angle and then as a function of the resonance decay angle. The results of the first experiment have already been published. The results of the second experiment are given. The two series of results are compared with the results derived from the Watson–Migdal model and with exact calculations made of the singlet amplitude (Ebenhoch). The coupled integral equations for the break-up of the deuteron are solved using the separable S-wave interaction. (France)

11037 (LYCEN–7252) PRECOMPOUND EMISSION INDUCED BY PROTONS AND ALPHA PARTICLES OF ABOUT 50-MeV EXCITATION ENERGY. Chevarier, A.; Chevarier, N.; Demeyer, A.; Hollinger, C.; Pertosa, P.; Tran Minh Duc (Lyon Univ. (France). Institut de Physique Nucleaire). Jul 1972. 2p. Dep. NTIS (U. S. Sales Only).

Proton and alpha emission spectra from nuclei in the ^{51}V to ^{206}Pb mass range at about 50 MeV were measured and analyzed in terms of statistical and precompound emission. (France)

11038 (ORO–2972-226(Task 2)) RESEARCH IN THEORETICAL NUCLEAR PHYSICS. Progress Report No. 11, December 1, 1971–November 30, 1972. Tamura, Taro (Texas Univ., Austin. Center for Nuclear Studies). 5 Dec 1972. Contract AT(40-1)-2972. 46p. Dep. NTIS.

Research in theoretical nuclear physics conducted in the Center for Nuclear Studies, under the auspices of the Division of Research of the U. S. Atomic Energy Commission, has produced 13 published papers, 8 papers in press, 4 invited papers, 10 orally delivered papers, 1 Ph.D. and 1 M.A. degree, during the period from 1 December 1971 to 1 December 1972. A broad, vigorous theoretical study of nuclear structure and nuclear reaction mechanisms continues, and additional work has dealt with atomic structure in collaboration with the experimental group of the Center. Significant progress has been made particularly in the theory of vibrational nuclei, and in understanding the role of two-step or multi-step processes in so-called "direct" nuclear reactions. (auth)

11039 DIFFUSION SOLUTIONS OF RECOILED NON-VOLATILE FISSION PRODUCTS IN SOLIDS. Ong, A. S. (Instituto Militor De Engenhoria, Rio de Janeiro); Zumwalt, L. T.; Fox, C. H. Nucl. Instrum. Methods; 105: No. 2, 383-5(1972).

Three different diffusion solutions were obtained for nonvolatile fission products recoiled into solids. The best series solution for computer calculations and a closed solution for thick samples are given. (2 figures) (auth)

11040 EFFECTS OF N* PRODUCTION ON NUCLEON–NUCLEUS SCATTERING. Ikeda, Miyo (Florida State Univ., Tallahassee). Phys. Rev., C.; 6: No. 5, 1608-19(Nov 1972).

The Glauber theory of multiple scattering is extended so as to include the contributions of N* production, and is applied to the elastic scattering of a nucleon from various nuclei for incident momenta in the range from 1.7 to 30 GeV/c. The momentum dependence of the nucleon–nucleus total cross sections is discussed. The influences of the inclusion of N* effects on the structure of the second maximum in the differential cross section is also investigated. (14 figures, 3 tables). (auth)

11041 SPIN–ORBIT COMPONENT OF OPTICAL MODEL FROM NUCLEAR MATTER: SPHERICAL AND DEFORMED CASES. Mackintosh, Raymond S. (Australian National Univ., Canberra). Nucl. Phys.; A192: No. 1, 80-4(1972).

A model of calculating the spin-orbit component of the nuclear optical potential from matter distributions is given. It is more direct than previous methods, and can be generalized to the case of deformed nuclei. (auth)

11042 CALCULATION OF MATRIX ELEMENTS OF THREE PARTICLE OPERATORS IN α-PARTICLE NUCLEI. Nash, G. F. (North West Kent Coll. of Tech., Dartford, Eng.). Proc. Cambridge Phil. Soc.; 72: No. 3, 457-8(Nov 1972).

A method is given for evaluating matrix elements of three-particle operators in many-nucleon states of [44 ... 4] symmetry. (auth)

11043 NUMERICAL CALCULATION OF THE ENERGY EIGENVALUES FOR A LOCAL POTENTIAL. Sirohi, A. P. S.; Srivastava, M. K. (Univ. of Roorkee, India). J. Phys., A (London); 5: No. 11, 1639-41(Nov 1972).

A recent method, based on obtaining a first order nonlinear differential equation, to calculate the energy eigenvalues for a local potential has been improved. Two transformations which are capable of greater maneuverability and which reduce computational labor are suggested. (auth)

11044 SOME EFFECTS OF CHARGE POLARIZATION IN NUCLEAR FISSION. Ryce, S. A. (Univ. of Victoria, B. C.); Wyman, R. R.; Stewart, A. T. Can. J. Phys.; 50: No. 18, 2217-27(15 Sep 1972).

It is shown that asymmetric mass division is to be expected in fission of a charged liquid drop if the charge is allowed to move freely between incipient fragments under the influence of the Coulomb field. For a nuclear fluid, forces which inhibit and which favor charge polarization are discussed. Parallels are drawn between the qualitative features of the polarizable liquid drop and fissioning nuclei. (auth)

11045 GENERATOR-COORDINATE WAVE FUNCTIONS SUITABLE FOR A MANY-BODY DESCRIPTION OF NUCLEAR REACTIONS. Wong, C. W. (Massachusetts Inst. of Tech., Cambridge). Nucl. Phys.; A197: No. 1, 193-210(1972).

Generator-coordinate wave functions suitable for nuclear reactions are constructed from Peierls–Thouless wave functions for separate clusters of nucleons. Antisymmetrization of the total wave function is achieved by ensuring that the basic many-body wave function in the Peierls–Thouless linear combination is a Slater determinant. A prescription is given for the calculation of operator matrix elements such that only smooth functions, and not Dirac δ-functions, are explicitly calculated. For certain oscillator single-particle wave functions the present method is shown to give results identical to those of previous formulations of the generator-coordinate method. The generator-coordinate wave functions used here are wave functions of good cluster momenta: momenta conjugate to the actual cluster cm coordinates, not their average values. Consequently the interaction kernel in coordinate representation is identically the kernel of the resonating-group theory. Finally channel-channel coupling is formally included by considering the Griffin–Hill–Wheeler variational equations as coupled-channel equations. (auth)

11046 COLLECTIVE VIBRATIONS OF INTRINSIC EXCITED STATES. Caldeira, M. H.; Pascoal, H.; Da Conceicao Ruivo, M.; Silva, E. M. (Univ., Coimbra). Nucl. Phys.; A197: No. 1, 265-72(1972).

A method is proposed for studying the collective vibrations of an excited intrinsic state, which is based on the generator-coordinate theory. The new aspect introduced is the description of the intrinsic excited state as a Tamm–Dancoff solution, whereas previously the intrinsic state associated with the generator-coordinate method has always been the Hartree–Fock ground state. The method has been applied with very good results to the solvable model of Lipkin et al. (auth)

11047 UNIQUENESS IN THE RADIAL DEPENDENCE OF THE OPTICAL POTENTIAL FOR ALPHA-NUCLEUS SCATTERING. Singh, P. P. (Indiana Univ., Bloomington); Schwandt, P. Phys. Lett.; 42B: No. 2, 181-5(27 Nov 1972).

It is shown that the extent to which the radial dependence of the phenomenological, local alpha–nucleus real potential V(r) is determined in a scattering experiment is controlled by an effective band pass in angular momentum encountered in the measurement. This band pass increases with energy and hence unique determination of V(r) to smaller radial distances becomes possible. (auth)

11048 MESON EXCHANGE EFFECTS ON THE DEUTERON MAGNETIC MOMENT. Horikawa, Y. (Juntendo Univ., Narashino, Japan); Fujita, T.; Yazaki, K. Phys. Lett.; 42B: No. 2, 173-6(27 Nov 1972).

Meson exchange correction to the deuteron magnetic moment is investigated by dividing it into the long range and the short range parts. The former is related to the pion-photo-production amplitude for which the ρ-meson exchange model is used, but its reliable estimation is difficult at present. The latter is calculated within the framework of the one-boson-exchange model which describes two-nucleon data quite well. It is found that the short range part is sufficient to explain the observed value of the deuteron magnetic moment. (auth)

11049 NUMERICAL STUDY OF DWBA IN A THREE-BODY MODEL OF STRIPPING. Bouldin, D. P.; Levin, F. S. (Brown Univ., Providence). Phys. Lett.; 42B: No. 2, 167-70(27 Nov 1972).

Spectator, adiabatic, and DWBA wave functions have been compared for a separable potential, three-body model of deuteron stripping. The spectator and adiabatic wave functions are shown to be identical in this model; their use in the stripping amplitude is exact. Detailed calculations are presented and analyzed for an incident energy of 6.7 MeV; these are similar to results obtained at energies of 1.78, 11.2, and 15.12 MeV. Although the resulting distributions are in good agreement, the adiabatic and DWBA wave functions and partial wave amplitudes do not agree too well, as in the many-body calculations of Harvey and Johnson. (auth)

11050 SPIN AND ISOSPIN DEPENDENCE OF THE SINGLE-PARTICLE POTENTIAL IN NUCLEAR MATTER. Dabrowski, J. (Inst. for Nuclear Research, Warsaw); Haensel, P. Phys. Lett.; 42B: No. 2, 163-6(27 Nov 1972).

The spin and isospin dependent parts of the single-particle potential in nuclear matter are calculated at the Fermi surface with the Brueckner–Gammel–Thaler and the Reid soft core potential. The spin-spin part of the optical model potential is estimated. The rearrangement effects turn out to be very important. (auth)

11051 TRUNCATION SCHEME FOR SHELL MODEL SPACES. Wong, S. K. M.; Gomez, J. M. G.; Zuker, A. P. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 42B: No. 2, 157-62(27 Nov 1972).

A truncation scheme is proposed that allows strong reductions in dimensionality for shell model calculations. The truncated wave functions are very close to the projections of the exact ones on the corresponding model spaces and can be obtained without renormalizing the Hamiltonian. Energies and transition rates exhibit a smooth behavior and suggest a simple relationship between model and bare operators. Spectroscopic results for ^{24}Mg are obtained that describe quite well known data. (auth)

11052 MICROSCOPIC (p,p') CALCULATIONS AND POLARIZATION CHARGES WITH LARGE BASIS SHELL-MODEL WAVE FUNCTIONS. Larson, D.; Austin, S. M.; Wildenthal, B. H. (Michigan State Univ., East Lansing). Phys. Lett.; 42B: No. 2, 153-6(27 Nov 1972).

Techniques have been developed for performing microscopic model DWBA calculations of inelastic nucleon-nucleus scattering using large basis shell-model wave functions to describe the nuclear states involved. For the case of ^{138}Ba at a bombarding energy of 30 MeV, good fits to the data are obtained by including the exchange amplitude in the DWBA and assuming a state and multipole independent polarization charge. (auth)

11053 COULOMB ENERGIES AND CHARGE ASYMMETRY OF NUCLEAR FORCES. Shlomo, S. (Weizmann Inst. of Sciences, Rehovot, Israel). Phys. Lett.; 42B: No. 2, 146-52(27 Nov 1972).

Charge-symmetry-breaking potentials suggested in the literature to resolve the discrepancy between calculated Coulomb energy differences of analog states and the experimental values, are considered in detail. The contributions of these potentials to the ground-state energy differences of the mirror nuclei ^{3}He–^{3}H, ^{15}O–^{15}N, ^{17}F–^{17}O, ^{39}Ca–^{39}K and ^{41}Sc–^{41}Ca are calculated. It turns out, due to the short range character of these symmetry-breaking potentials, that their inclusion may resolve the ^{3}He–^{3}H difficulty but not the ^{41}Sc–^{41}Ca discrepancy. (auth)

11054 SEMI-EMPIRICAL INTERPRETATION OF NUCLEAR FISSION BASED ON DEFORMED-SHELL EFFECTS. Wilkins, B. D.; Steinberg, E. P. (Argonne National Lab., IL). Phys. Lett.; 42B: No. 2, 141-5(27 Nov 1972).

The main features of the fragment mass and charge distribution in the fission of nuclides from Po to Fm are accounted for using a correlation of minimum potential energy with fragment yield. The potential energy is calculated from a liquid drop surface with deformed-fragment shell and pairing corrections at a particular deformation for the nascent fission fragments. (auth)

11055 TWO-NUCLEON TRANSFER REACTIONS BETWEEN COMPLEX IONS. Roberts, A. (Univ. of Manchester, Eng.). Nucl. Phys.; A196: No. 3, 465-97(1972).

A general expression is derived within the framework of DWBA for the amplitude for two-nucleon transfer between heavy ions at sub-Coulombic energies. The effects of two-nucleon configuration mixing and two-nucleon correlations on this amplitude are discussed, and it is suggested that there are ambiguities in the asymptotic form of the two-nucleon wave function which must be resolved before unambiguous spectroscopic information can be extracted from this type of reaction. The extension of the theory to include optical-model potentials is considered and it is shown that these potentials can lead to some understanding of the available data. Finally, the question of the validity of DWBA in describing the reaction mechanism for these reactions is considered. (auth)

11056 MODEL FOR DESCRIBING THE STRUCTURE OF HIGHLY EXCITED STATES IN DEFORMED NUCLEI. I. Solov'ev, V. G.; Malov, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys.; A196: No. 3, 433-51(1972).

A model for describing states of intermediate and high excitation energy in deformed nuclei which is based on the quasiparticle-phonon interaction is suggested. A secular equation for determining the energy and the wave functions is obtained by means of the variational principle. The neglect of the non-coherent terms leads to the appearance of extraneous states. A method for eliminating them is developed. On the basis of the calculations performed for ^{239}U, at an energy close to the neutron binding energy, the average spacing between the $1/2^{+}$ states is found to be 33 eV which is twice as large as the experimental value. The magnitude of the one-quasiparticle components is between 10^{-7} and 10^{-11}. The increase of the density of the states with increasing excitation energy is demonstrated. It is concluded that the quasiparticle-phonon interaction is responsible for both the complication of the state structure with increasing excitation energy and the fragmentation of the one-particle states over many nuclear levels. (auth)

11057 COMPILATION AND EVALUATION OF NUCLEAR DATA. Ribon, P. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 170, 79-85(May 1972). (In French).

Problems arising in the compilation and evaluation of neutron data (i.e., data concerned with fission reactors) are discussed. The international organization existing for these neutron data is presented. This organization deals very efficiently with the data. The need for non-neutron data has recently become apparent and the necessary international cooperation is being considered. (France)

11058 QUARTET STRUCTURES IN MEDIUM-WEIGHT NUCLEI. Faraggi, H. (CEN de Saclay, Gif-sur-Yvette, France). Comments Nucl. Particle Phys.; 5: No. 3, 79-84 (May 1972).

A review is presented on matters relating to the concept of quartet structures in medium-weight nuclei. The quartet model emphasizes the importance of four-nucleon correlations in nuclei. Interactions within quartets made by the coupling of two aligned proton-neutron pairs are large, whilst interactions between quartets are much weaker. These facts have been discussed with reference to nuclear masses, spectroscopic data, and microscopic calculations such as Hartree–Fock or con-

figurational mixing. The existence of quartets entails low lying many-particle excitations, corresponding to the breaking of bonds between quartets, that are similar or even lower in energy than "single particle" excitations, which break bonds within a quartet. An example is the well known four particle-four hole states in ^{16}O, and it has been conjectured that transfer of strongly correlated two-proton-two neutron structures, such as in (^{16}O, ^{12}O) reactions, should show some selectivity in populating these states made of four excited particles strongly correlated. With the use of the (^{16}O, ^{12}C) reaction it has been found possible to make studies in the 2p-1f shell, and results obtained for several residual nuclei between ^{44}Ti and ^{68}Zn are in overall qualitative agreement with the predictions of a quartet model. The question arises as to whether or not α-transfer reactions bring evidence for quartet states in medium weight nuclei, and this problem has been the theme of very active and controversial international discussion. New results discussed show that, although reaction mechanisms play a part, nuclear structure effects are also important. What is known about the reaction mechanism is still of a qualitative character, but it appears to be dominated by Coulomb effects. The matter of Q value dependence is discussed. Experimental work at Saclay and Munich on α-transfer reactions with heavy ion beams is mentioned. Experiments performed in the 1f-2p shell have shown that quarteting as pairing is an important effect of the residual shell model interaction. (15 references) (UK)

11059 ENERGY-OF-DEFORMATION CALCULATIONS. Wilets, L. (Univ. of Washington, Seattle). Comments Nucl. Particle Phys.; 5: No. 3, 89-93(May 1972).

Reference is made to the Unified Model, the foundation of which was laid with the suggestion by Rainwater (Phys. Rev. 79 : 432 (1950)) that a few extra-core nucleons could collectively deform the nuclear core, resulting in a large static quadrupole moment. There is great interest in the deformation energy function on account of the fundamental role it plays in fission and heavy ion reactions. Methods of attack on energy of deformation calculations are discussed under the following headings: employment of the best many-body techniques; constrained Hartree–Fock calculations; use of variations of the Strutinsky prescription (Nucl. Phys. A122: 1 (1968)); and the Strutinsky shell correction method. (17 references) (UK)

11060 POLARIZATION TRANSFER AND SPIN CORRELATION EXPERIMENTS IN NUCLEAR PHYSICS. Ohlsen, G. G. (Los Alamos Scientific Lab., NM). Rep. Progr. Phys.; 35: No. 7, 717-801(1972).

The review (completed in March 1972) is concerned with nuclear reactions and nuclear elastic scattering in which the spin polarization of more than one of the reactants is measured. If both of the particles whose polarization is known are in the initial channel, or both in the final channel, a "spin correlation" experiment is referred to; if one polarized particle is in the initial and one is in the final channel, a "polarization transfer" experiment is referred to. Consideration is given mainly to particles with spin $\frac{1}{2}$ and with spin 1; to a minor extent higher spins are included. The state of the art with respect to the production of polarized beams and targets and with respect to polarization analyzing devices is briefly reviewed. A considerable amount of space is devoted to the definitions of cartesian polarization transfer and spin correlation coefficients which are suitable for the description of reactions involving spin $\frac{1}{2}$ and spin 1 particles. These parameters are generalizations of the triple scattering and spin correlation parameters introduced by Wolfenstein for a description of nucleon-nucleon scattering. Finally, the experiments of these types so far performed are reviewed. Reactions involving photons are excluded, and the nucleon-nucleon problem is only briefly mentioned. (auth)

11061 TWO INTERACTING PARTICLES IN THE POTENTIAL HOLE. Migdal, A. B. (Inst. of Theoretical Physics, Moscow). Yadern. Fiz.; 16: No. 2, 427-34(Aug 1972). (In Russian).

The problem of the energy spectrum for two interacting particles in the potential hole with the resonance level whose energy is close to 0 was solved. It is shown that under particular conditions an additional bound state may arise. This bound state is not allowed by perturbation theory. Some applications in the nuclear theory are being discussed, in particular the possibility of bineutron existence near the surface of some nuclei. (auth)

11062 SKYRME'S INTERACTION IN THE ASYMPTOTIC BASIS. Quentin, P. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris); 33: No. 5, 457-63(May 1972).

Matrix elements of the two-body, three-body, and spin-orbit parts of the Skyrme interaction are calculated analytically on the asymptotic basis. These matrix elements only involve combinations of simple functions and their numerical evaluation is consequently rather easy. The matrix elements of a Gaussian interaction are also calculated on this basis. Finally, a method is proposed for deriving the elements of Yukawa or Coulomb interaction matrix from the Gaussian interaction matrix elements. (France)

11063 EXPONENTIAL DECAY LAW OF NONSTABLE PARTICLE. Terent'ev, M. V. (Inst. for Theoretical and Experimental Physics, Moscow). Ann. Phys. (N. Y.); 74: No. 1, 1-42 (Nov 1972).

The problem of time dependence of the probability of decay of nonstable particle is studied. It is argued that in the framework of quantum mechanics the exponential decay law exp ($-\gamma t$) must be valid practically at any values of time t, or more precisely, the better the experimental set up, the farther the exponential decay law may be seen. (auth)

11064 COMPLEX COORDINATE METHOD FOR THREE-PARTICLE SCATTERING ABOVE THE BREAK-UP THRESHOLD. Hendry, J. A. (Univ. of Liverpool). Nucl. Phys.; A198: No. 2, 391-6(1972).

The complex-coordinate method is used to evaluate the elastic scattering above the breakup threshold in a model three-body system. The results are compared with previous estimates. (2 figures, 1 table). (auth)

11065 VALIDITY OF SPECTRAL DISTRIBUTION METHODS IN SPECTROSCOPY. Chang, F. S. (Univ. of Rochester, NY); Zuker, A. Nucl. Phys.; A198: No. 2, 417-29(1972).

The accuracy with which various spectral distributions reproduce the energies in many-particle spectra was studied by comparing the results with those from exact (ds) shell calculations of dimensionalities ranging up to 1200. The splitting of the deviations, between the distribution and exact spectra, into a fluctuating part and a part which varies slowly with energy, as well as the accuracy with which the distribution method reproduces the orbit occupancies over the entire range of excitation energies, the level density and spin-cut-off factor, was also investigated. Agreement in all cases is good. (6 figures, 3 tables). (auth)

11066 PARITY CONSERVATION AND POLARIZATION PHENOMENA FOR BREAK-UP REACTIONS. Knutson, L. D. (Univ. of Wisconsin, Madison). Nucl. Phys.; A198: No. 2, 439-48(1972).

The conservation of parity is known to place restrictions on the polarization observables for nuclear reactions. For reactions which lead to a final state that contains two particles, the number of nonzero polarization observables is reduced by about a factor of two. Restrictions are established on the various polarization observables resulting from parity conservation for reactions in which the final state contains three particles. It is shown that for certain special cases the restrictions have a form similar to that for reactions in which the final state contains two particles. (auth)

11067 COMPARING OF METHODS FOR DETERMINING NUCLEAR MATRIX ELEMENTS IN FIRST-FORBIDDEN β-DECAY. Schweitzer, J. S.; Simms, P. C. (Purdue Univ., Lafayette, IN). Nucl. Phys.; A198: No. 2, 481-93(1972).

The results of matrix element extraction made by different groups in a number of recent papers have been observed to be inconsistent. Since there seemed to be a correlation between the formulation used and the results obtained, the two basic treatments of the theory are compared. The comparison shows that the two methods should give very similar results unless higher-order matrix elements are unusually important. The inconsistent results appear to be caused by the way in which the matrix element extractions are performed rather than by a basic difference in the formulas. The matrix elements for the 2^- (0.959 MeV) 2^+ β transition in ^{198}Au are reviewed to illustrate how differences in technique can affect the results. (4 figures, 6 tables). (auth)

11068 NUCLEAR SIZE EFFECTS IN THE POLARIZATION OF ELASTICALLY SCATTERED POSITRONS. Ugincius, P. (Naval Weapons Lab., Dahlgren, VA); Ueberall, H. Nucl. Phys.; A198: No. 2, 494-504(1972).

A previous calculation of polarization effects in the elastic Coulomb scattering of electrons from point and extended nuclei is extended to the case of positrons. The polarization function $S(\theta)$ is found to be of smaller magnitude and opposite sign as compared to that for electrons in the scattering from a point nucleus; but the effects of nuclear size turn out to be relatively much stronger for positrons, leading to sign reversals for positron energies above 50 MeV. (14 figures). (auth)

11069 SHELL CORRECTION ENERGIES DERIVED FROM STATISTICAL ENTROPY CALCULATIONS. Bengtsson, Ragnar (Lund Inst. of Tech., Sweden). Nucl. Phys.; A198: No. 2, 591-7(1972).

Shell correction energies were calculated by studying the temperature dependence of the entropy on the basis of realistic single-

particle level spectra. It is shown that from statistical calculations it is possible to derive a well-defined shell correction energy, which almost entirely coincides with the shell energy calculated by the Strutinsky method. (4 figures). (auth)

11070 RELATIVISTIC ONE-BOSON EXCHANGE POTENTIAL AND NUCLEAR-MATTER PROPERTIES. Holinde, K.; Erkelenz, K.; Alzetta, R. (Univ., Bonn). Nucl. Phys.; A198: No. 2, 598-608(1972).

The infinite-nuclear-matter properties of our momentum space OBEP were calculated to the first order of the Brueckner–Goldstone reaction matrix, G, by using the angle-averaged Pauli operator, the effective mass approximation for the hole spectrum (determined self-consistently), and a free-particle spectrum. The results (12.4 MeV binding at a saturation density of $k_F = 1.55$ fm^{-1}, compression modulus K = 170 MeV, and defect parameter $\kappa = 0.11$ for $k_F = 1.5$ fm^{-1}) are compared with corresponding results of other potentials. It turns out that the meson retardation, i.e., the covariant off-shell continuation of the potential, has a large influence on the results. (auth)

11071 HOLE STATES IN NUCLEI AND THE CONTINUUM SHELL MODEL. Fritsch, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Lipperheide, R.; Wille, U. Nucl. Phys.; A198: No. 2, 515-28(1972).

The hole spectral function which determines the cross section of direct nucleon removal processes is studied in the framework of the continuum shell model with residual interactions. An expression for the spectra function is derived which covers both the bound and continuous parts of the hole spectrum and allows for an exact inclusion of all correlations (except for continuum–continuum coupling) in a restricted space of shell-model configurations. The shell-model approach is compared to the Green's function formulation of the spectral function, and some formal relationships between both formulations are established. The results of previous calculations of the spectral function via a second-order mass operator are discussed in the light of the shell-model formalism. (auth)

11072 APPROXIMATE TREATMENT OF COULOMB EFFECTS IN THE NUCLEAR THREE-BODY PROBLEM. Bencze, Gy. (Central Research Inst. for Physics, Budapest). Nucl. Phys.; A196: No. 1. 135-44(1972).

An approximate treatment of Coulomb forces in the nuclear three-body problem is proposed which is based on the assumption that three-body dynamics are dominated by the nuclear interactions. Approximate three-particle integral equations are derived which incorporate Coulomb effects and have structure identical to the Alt–Grassberger–Sandhas equations. (auth)

11073 HAUSER–FESHBACH THEORY IN THE PRESENCE OF DIRECT REACTIONS. Weidenmueller, H. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 42B: No. 3, 304-6(11 Dec 1972).

Hauser–Feshbach formulas including the effect of direct reactions and obtained recently by Kawai, Kerman, and McVoy are rederived and extended with the help of only weak and general assumptions on the partial width amplitudes. (auth)

11074 NOTE ON MASS ASYMMETRY AND SHELL EFFECTS IN NUCLEAR FISSION. Andersen, B. L. (Danmarks Ingenioerakademi, Lyngby, Denmark). Phys. Lett.; 42B: No. 3, 307-9 (11 Dec 1972).

Simple considerations based on the two center shell model lead to an understanding of the particular role which has been assigned to single-particle orbits of the type [40 Λ Ω] and [51 Λ Ω] in connection with the onset of asymmetry around the second peak of the fission barrier. (auth)

11075 HEXADECAPOLE COLLECTIVE MOTION IN SPHERICAL NUCLEI. Goswami, A. (Univ. of Oregon, Eugene); Lin, L. Phys. Lett.; 42B: No. 3, 310-12(11 Dec 1972).

The hexadecapole-collective motion in spherical nuclei is discussed. Numerical calculations are presented and compared with available experimental data. (auth)

11076 ELASTIC AND INELASTIC SCATTERING OF 1-GeV PROTONS BY ^{12}C. Starodubskii, V. E.; Domchenkov, O. A. (Inst. of Nuclear Physics, Leningrad). Phys. Lett.; 42B: No. 3, 319-22(11 Dec 1972).

The differential cross sections of both elastic and inelastic (2^+, 4.43 MeV) scattering of 1-GeV protons by ^{12}C are calculated in terms of the Glauber theory. Inclusion of the deformation enables one to achieve a good agreement in a simultaneous description of both elastic and inelastic (2^+) proton and electron scattering experiments. (auth)

11077 BOUND STATES IN A SYSTEM OF FOUR IDENTICAL PARTICLES. Kharchenko, V. F.; Kuzmichev, V. E. (Inst. for Theoretical Physics, Kiev). Phys. Lett.; 42B: No. 3, 328-30 (11 Dec 1972).

The energies of the bound S-states of the four identical particles with separable pair interactions are calculated on the basis of the integral equations for the system. It is found, besides the ground states of the four-particle system, a second 0^+ bound state. (auth)

11078 EFFECT OF RECOIL ON SINGLE-NUCLEON TRANSFER IN HEAVY-ION REACTIONS. Nagarajan, M. A. (Univ. of California, Berkeley). Nucl. Phys.; A196: No. 1, 34-40(1972).

An approximate treatment of the effect of recoil in single-nucleon transfer in heavy-ion reactions is outlined. It is shown that the effect of recoil is to remove the restrictions on the orbital angular-momentum transfer. The effect of recoil is shown to depend upon the energy of the projectile, becoming more significant at higher projectile energies, and for the case where the neutron binding to the residual nucleus is small, it is more important for smaller final binding energies. A simple expression is obtained for the recoil amplitude and cross section for p-wave projectiles. (auth)

11079 SELECTION RULE FOR K-HARMONICS FOR ^{3}H AND ^{4}He. Englefield, M. J. (Monash Univ., Clayton, Australia). Nucl. Phys.; A181: No. 1, 305-18(1972).

Wave functions for ^{3}H and ^{4}He are formed by combining K-harmonics of definite permutation symmetry with spin-isospin functions of adjoint symmetry. Applying Young operators to K-harmonics formed by vector coupling gives the required symmetrized functions, which are then expressed as linear combinations of the vector-coupled K-harmonics to allow potential matrix elements to be written down by techniques used in shell-model calculations. Explicit formulas are given for central and tensor potentials. Results obtained by other authors suggest that for convergence expansions in K-harmonics should be taken to about K = 8, so that some selection of states is essential. A rule used previously in variational calculations is to take only those states coupled by the potential to the zeroth approximation (K = 0). The form obtained here for the matrix elements and some properties of Young operators lead to a method of constructing these states. (auth)

11080 POLARIZATION CHARGE OF E4 TRANSITIONS IN THE LEAD REGION. Hamamoto, Ikuko (Univ., Munich). Nucl. Phys.; A196: No. 1, 101-6(1972).

The frequencies and collectivities of high-lying isoscalar and isovector modes with $\lambda = 4$ are estimated for the nucleus ^{208}Pb. The results, together with the observed properties of the 4^+ state at 4.30 MeV, are used to estimate the polarization charge of E4 transitions in the lead region. The calculated polarization charge is in good agreement with a recent measurement of the crossover $4^+ \rightarrow 0^+$ transition in ^{204}Pb. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

Confinement and Heating

11081 (COO-3170-1(Paper 3)) PLASMA HEATING BY INTENSE RELATIVISTIC BEAMS DUE TO THE TWO-STREAM INTERACTION. Thode, L. E.; Sudan, R. N. (Cornell Univ., Ithaca, NY). Sep 1972. 73p. (LPS-96).

In Theoretical studies on astron stability.

A theory of the relativistic beam–plasma interaction is presented and compared with a one-dimensional computer-simulation experiment. It is assumed that the beam interacts with an unstable wave spectrum so narrow that it may be regarded as a single wave. From a qualitative analysis of this model, the maximum electric field energy is given by $W \equiv |E_M|^2/_{16}\pi n_b mc^2\gamma_0 = {}^1/_2 S(1+S)^{-1/2}$ where $S \equiv \beta_0^3\gamma_0(n_b/2n_e)^{1/3}$ is a strength parameter, n_b and n_e are beam and plasma electron densities, respectively, $\beta_0 = v_0/c$, $\gamma_0 = (1-\beta_0^2)^{-1/2}$, and v_0 is the mean beam velocity. The numerical experiments show that $W = 0.158\ S$ for $S \leq 0.6$, reaches a maximum $W \sim 0.1$ at $S \sim 0.6$, and decreases monotonically for $S > 0.6$. The theoretical expression agrees with these results except for $S \ll 1$, where indeed the single-wave model may be breaking down because the spectrum is not being totally dominated by one wave. This anomalous heating results in essentially all the energy lost by the beam going into electron heating. (auth)

11082 NEOCLASSICAL THEORY OF LANDAU DAMPING AND ION AND ELECTRON TRANSIT-TIME MAGNETIC PUMPING (TTMP) IN TOROIDAL GEOMETRY. Canobbio, E. (CEN, Grenoble, France). Nucl. Fusion; 12: No. 5, 561-8(Sep 1972).

The exact nonlinear calculation, to lowest order in the wave amplitude, of the electromagnetic power absorption by a uniform plasma in the small-collision-frequency limit. The absorption is determined by the average rate of irreversible entropy increase as produced by the full Fokker–Planck operator including both like- and unlike-species collisions. The explicit form of the velocity distribution function of the resonant particles is directly obtained from the relevant nonlinear Vlasov equation. The paper treats the case of a purely electrostatic wave in straight geometry, the case of compression and shear magnetic waves in toroidal geometry for electron heating, and makes two corrections to previous results on ion TTMP heating. The limits of validity of the collisionless linear calculations of power absorption in the above problems as a function of the collision frequency are established in an intrinsically more exact way than in any previous evaluation. (auth)

11083 EXPERIMENTAL OBSERVATION OF HEATING OF A HYDROGEN PLASMA BY A RELATIVISTIC ELECTRON BEAM. Smith, D. R. (Sandia Labs., Albuquerque, NM). Phys. Lett.; 42A: No. 3, 211-12(4 Dec 1972).

Diamagnetic loop measurements of the heating of a hydrogen plasma by a pulsed, relativistic electron beam indicate strong heating during the decay part of the beam pulse. (auth)

11084 TRANSVERSE AND LONGITUDINAL HEAT FLOW IN A LASER-HEATED MAGNETICALLY CONFINED PLASMA. Fay, S. W.; Jassby, D. L. (Univ. of California, Los Angeles). Phys. Lett.; 42A: No. 3, 261-2(4 Dec 1972).

A fully ionized magnetically confined arc plasma is heated with CO_2-laser radiation. Heat propagation along and across the magnetic field is measured. (auth)

11085 EXTERNAL HIGH-FREQUENCY MODULATION OF ELECTRON BEAM AND HEATING OF THE PLASMA IONS AT BEAM INSTABILITY IN MIRROR MACHINE. Kovpik, O. F.; Kornilov, E. A.; Kolyada, Yu. E.; Lifshits, E. V. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 734-8(May 1972). (In Russian).

The mechanism of the ion acceleration was investigated at the beam–plasma interaction in a mirror machine. It was found that the ions are accelerated due to oscillations of near ion-cyclotron frequency. The mechanism of acceleration is stochastic. Low-frequency oscillations are excited by nonlinear interactions of high-frequency oscillations. High-frequency modulation of the beam leads to appearance of low-frequency oscillations; high-frequency modulation of the beam is more effective for the ion acceleration than a direct increase of the beam power. The current of the beam was 1 to 20 A with energy of 5 to 25 keV and magnetic field 3 to 1 to 3 kG. Plasma density was 10^{11} to 10^{13} cm^{-3} electron/cm^3. Beam was modulated by oscillation frequency of 2800 MHz. (auth)

11086 CAPTURE OF PLASMA INJECTED INTO THE INJECTOR–DIVERTOR DEVICE OF A STELLARATOR IN CASE OF A SHORT- AND LONG-TERM MODULATION OF THE CONFINING MAGNETIC FIELD. Atamanov, N. S.; Zalkind, V. M.; Zykov, V. G.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 368-71(Mar 1972). (In Russian).

It is shown that in the case of plasma injection into the injector-divertor device of a stellarator it is possible to regulate the length of the plasma stream captured in the trap. The effect is achieved by means of changing the pulse duration of the magnetic field directed against the basic magnetic trap. (auth)

11087 MOTION OF PLASMOIDS IN A TOROIDAL MAGNETIC MULTIPOLE. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 957-62(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1204-11(Jun 1972).

Plasma flow across a toroidal octupole field is studied. It is found that the axial distribution of plasma moving along the magnetic axis is determined by the orientation of the velocity vector and the direction of the current in the conductors creating the octupole field. This effect is related to the generation of a polarization axial electric field at the head of the plasmoid. Purification of the jet of neutral gas and heavy-ion impurities can occur as the jet moves along the curvilinear multipole field. (auth)

11088 TRANSPORT EQUATIONS FOR DILUTE PLASMA IN A MAGNETIC FIELD. Price, J. C. (Goddard Space Flight Center, Greenbelt, MD). Phys. Fluids; 16: No. 1, 90-4(Jan 1973).

Equations are derived for near-equilibrium transport of plasma in a strong magnetic field. These equations reduce to the collision-dominated (fluid) equations, and to the collisionless (Chew–Goldberger–Low) equations in the respective limits. (auth)

11089 NEOCLASSICAL PLASMA TRANSPORT IN AXISYMMETRIC TOROIDAL SYSTEMS. Glasser, A. H.; Thompson, W. B. (Univ. of California, San Diego, La Jolla). Phys. Fluids; 16: No. 1, 95-110(Jan 1973).

The variational technique for calculating all the neoclassical transport processes in the banana regime, developed by Rosenbluth, Hazeltine, and Hinton for the case of tokamak with small rotational transform and large aspect ratio, is generalized to arbitrary axisymmetric toroidal systems with a small fraction of trapped particles. The use of the scalar magnetic potential as a coordinate, as in Rutherford's treatment of the Lorentz model, is eliminated by the use of a coordinate-free solution procedure, allowing the treatment of nonvacuum fields. As an example, results are given for Doublet II. (auth)

11090 FAST RADIAL DISPLACEMENT OF A TOROIDAL PLASMA BY A TRANSVERSE MAGNETIC FIELD. Kaganskii, M. G.; Ovsyannikov, V. A.; Tyul'panov, S. S. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1229-31(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1537-9(Jul 1972).

Experimental results obtained with the Truman-2 device are described. A transverse field up to 60 Oe with rise time 50 μsec is applied to an equilibrium plasma carrying a longitudinal current up to 5 kA located inside a conducting liner. For small displacements the radial velocity is determined by the rate of rise of the transverse field. In these experiments velocities up to 3×10^5 cm/sec were obtained. At larger displacements the plasma is slowed down suddenly. It is proposed that this effect results from a transverse current, which is closed through the limiter. (auth)

11091 CONVERSION OF TRAPPED CHARGED PARTICLES INTO UNTRAPPED PARTICLES IN A HIGH-FREQUENCY ELECTRIC FIELD. Demirkhanov, R. A.; Stotland, M. A.; Khil, Sh. V. (Physical-Technical Inst., Sukhumi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1128-31(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1419-22(Jul 1972).

The effect of a high-frequency electric field on the motion of charged particles is studied in a toroidal magnetic trap with a rotational transform. Particles trapped in inhomogeneities of the magnetic field can be transformed into untrapped particles by the application of a longitudinal toroidal high-frequency electric field with frequency Ω comparable with the bounce frequency between the magnetic mirrors, ω_b. In a stellarator with a small aspect ratio ($\epsilon_t \ll \epsilon_h$, where $\epsilon_t = r/R_0$ is the aspect ratio and ϵ_h is the helical magnetic field) and noncircular magnetic surfaces, the same effect can be achieved by applying a multipole high-frequency field with frequency $\Omega \gg \omega_b$. Conversion of trapped particles into untrapped particles requires in both cases that $\tilde{V}/V_0 \simeq \epsilon_h^{1/2}$, where $\tilde{V}$ and V_0 are the oscillatory and the total initial velocity of the particle. (auth)

11092 MICROWAVE HEATING OF A PLASMA AND LONGITUDINAL ELECTRONIC THERMAL CONDUCTIVITY IN A MAGNETIC FIELD. Zhilinskii, A. P.; Liventseva, I. F.; Safronov, Yu. M. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1116-22(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1404-12(Jul 1972).

A study is made of the electronic thermal conductivity along the magnetic lines of force in helium at a pressure of 0.1 mm Hg. The electron gas is locally heated by means of a microwave cavity. The heating can be regarded as localized within the cavity for electron densities $n_0 <$ (5 to 7)n_c at the center of the device. Under these conditions the thermal relaxation distance measured in the homogeneous portion of the plasma column agrees with values calculated from collisional transport theory. At densities $n_0 =$ (5 to 7)n_c the electron gas is heated outside the cavity. This effect can be explained on the basis of the absorption of a strongly retarded electromagnetic wave excited within the cavity and propagating along the plasma column, which is inhomogeneous in density. (auth)

Diagnostics

Refer also to abstract 11162.

11093 SPECTROSCOPY OF LABORATORY PLASMAS. Burgess, D. D. (Imperial Coll. of Science and Tech., London). Space Sci. Rev.; 13: No. 4-6, 493-527(1972).

Work under the heading of Laboratory Plasma Spectroscopy may be conveniently separated into three classes depending on the extent to which the interaction of the emitting atoms with their plasma environment is central to the investigation. Zero-order, the longest established use of laboratory plasmas in connection with astrophysics, concerns the use of hot plasmas for the excitation, measurement, and identification of the spectra of highly stripped ions. In such work the properties of the plasma itself are usually of secondary importance. In first-order, plasma spectroscopy is used to determine fundamental atomic data concerned with the interaction of an atom with a single particle, usually either a photon or an electron; i.e., the determination of oscillator strengths and collision cross sections. Finally, higher-order processes in which the plasma nature of the surrounding medium is most relevant, concern the study of line shapes, and related topics such as the excitation of satellite spectral features by plasma oscillations. Developments in plasma diagnostic techniques in the last five years have greatly extended the scope of the second and third categories and have yielded much astrophysically important information from laboratory studies. Recent advances in these areas are reviewed. (146 references) (auth)

11094 DETERMINATION OF THE SPATIAL DISTRIBUTION OF A PLASMA WITH A MICROWAVE RESONATOR. Moskalev, I. N.; Stefanovskii, A. M. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 974-81(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1224-34(Jun 1972).

In the determination of the absolute value of the density of a plasma by means of a microwave resonator it is necessary to know the spatial distribution of that density with respect to the coordinates, $N(r,\varphi)$. The theoretical possibilities of determining the function $N(r,\varphi)$ from the results of resonator measurements with many modes are discussed in the article. It is shown that the reconstruction of an arbitrary function $N(r,\varphi)$ is not possible. The problem can always be solved, however, if the form of the isodensity lines is known. (auth)

11095 BOUNDARY-VALUE PROBLEM FOR A LANGMUIR PROBE IN A DENSE PLASMA. Yastrebov, A. A. (Central Aerological Observatory, Dolgoprudnyi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 910-17(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1143-53(Jun 1972).

Probe measurements are considered in a dense ($\lambda \ll a$) weakly ionized ($N/N_m < 10^{-3}$ to 10^{-4}) plasma under stationary conditions with allowance for a high-velocity incoming stream (λ is the mean free path of the charged particles, a is the characteristic linear dimension of the probe, and N and N_m are the densities of the charged and neutral components of the plasma). The method developed for solving nonlinear singular boundary-value problems with inhomogeneous boundary conditions by means of a computer makes it possible to obtain exact numerical solutions taking account of all the processes that enter into probe operation. (auth)

11096 ENERGY BROADENING OF THE PRIMARY ELECTRONS. Amemiya, H.; Wiesemann, K. (Univ., Marburg, Ger.). Phys. Lett.; 42A: No. 3, 221-2(4 Dec 1972).

The energy broadening of the primary electron beam in a low-pressure discharge was measured using spherical and cylindrical probes. The two probes deliver quite different results, the difference being due to the anisotropy of the broadening process. By comparing the distribution functions as obtained by the two probes it is possible to obtain the one-dimensional distribution function of the beam electrons. (auth)

11097 THEORY OF RF FIELDS IN A NONUNIFORM PLASMA WITH APPLICATION TO THE DIPOLE SPHERE RESONANT PROBE. De Angelis, D. L. New Haven; Yale Univ. (1972). 150p. University Microfilms Order No. 72-29,533.

Thesis.

Resonance effects can occur when an rf signal is applied to a spherical probe immersed in a plasma, the most prominent of these being the "cold plasma" resonance. This resonance is analyzed on the basis of the linearized Vlasov equation, taking into account the electron thermal effects and the nonuniform electron density surrounding the probe. In the limit where the probe is many Debye lengths in radius, an inner–outer type analysis is made, treating the sheath region one-dimensionally and the outer region from the cold dielectric point of view. Employing existing numerical solutions of the one-dimensional coupled Vlasov and Maxwell equations for simple sheath density profiles, admittance curves for the dipole sphere probe are obtained. These results compare well with experimental measurements, when the sheath profile approximates the physically expected electron density in the sheath. Generalization to sheath profiles of arbitrary form, again where the probe radius is large compared with the Debye length, is accomplished by means of a variational technique applied to the coupled Vlasov and Maxwell equations. Use of a plausible sheath profile yields admittance curves comparing favorably with the the experimental curves. (Diss. Abstr. Int., B)

11098 CONTINUUM ELECTROSTATIC PROBE THEORY WITH MAGNETIC FIELD. Niyogi, K. K.; Cohen, I. M. (Univ. of Pennsylvania, Philadelphia). Phys. Fluids; 16: No. 1, 69-74(Jan 1973).

A continuum electrostatic probe theory is developed for a slightly ionized, collision-dominated plasma in the presence of a uniform magnetic field. The governing equations are nonlinear and coupled. A quasi-linearization technique is applied to solve the equations numerically using finite difference approximations, in the case of spherical probes larger than a Debye length, the magnetic field being weak. When the probe size is not very large or the probe potential is small, the detailed analysis of the sheath is not necessary. But when the probe potential is large, the sheath needs a separate treatment. The sheath equations are essentially one-dimensional and the magnetic field parameters do not appear explicitly. In the absence of an analytic solution for either the sheath or the main region, both solutions are matched numerically in an overlap region. The effect of magnetic field on the nature of the distribution of the charged particles and the potential in space and on the probe surface is investigated in detail. The phenomenon of "potential overshoot" in the case of a probe biased near plasma potential is clearly revealed. A few representative current–voltage characteristics at various magnetic fields are drawn. A systematic procedure for the interpretation of the probe characteristics is developed. (auth)

11099 RECENT ADVANCES IN PLASMA DIAGNOSTICS. VOLUME I. OPTICAL TECHNIQUES. Tolok, V. T. (ed.). New York; Plenum Publishing Corporation (1971). 134p. $22.50.

Translated from Russian by Joachim R. Buechner.

Twenty-one papers are included on optical methods for plasma diagnostics. (M.O.W.)

11100 RECENT ADVANCES IN PLASMA DIAGNOSTICS. VOLUME II. MICROWAVE TECHNIQUES. Tolok, V. T. (ed.). New York; Plenum Publishing Corporation (1971). 109p. $22.50.

Translated from Russian by Joachim R. Buechner.

Seventeen papers are included on microwave methods for plasma diagnostics. (M.O.W.)

11101 RECENT ADVANCES IN PLASMA DIAGNOSTICS. VOLUME III. CORPUSCULAR, CORRELATION, BOLOMETRIC, AND OTHER TECHNIQUES. Tolok, V. T. (ed.). New York; Plenum Publishing Corporation (1971). 77p. $13.50.

Translated from Russian by Joachim R. Buechner.

Twelve papers are included on corpuscular, correlation, bolometric, and other techniques for plasma diagnostics. (M.O.W.)

11102 DETERMINATION OF PARAMETERS OF LASER-INDUCED PLASMA IN AIR BY A SCATTERING METHOD. Malyshev, G. M.; Razdobarin, G. T.; Semenov, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1137-9(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1429-31(Jul 1972).

Scattering of light from a probe laser is used to determine the parameters of the plasma at the center of a laser spark in air at atmospheric pressure 11 μsec after the plasma is formed. The spectrum of the scattered light is obtained and the total intensities of the electron and ion components of the spectrum and the intensity of Rayleigh scattering by air at atmospheric pressure are determined. This information is utilized to calculate the electron density and temperature and the mean ion charge in the plasma. The electron temperature and density in the spark produced by a laser beam of energy 1 to 2 J are $T_e = (1.4 \pm 0.2) \times 10^4$°K and $n_e = (1.2 \pm 0.1) \times 10^{17}$ cm^{-3}. (auth)

11103 X-RAY SOURCE FOR DIAGNOSTICS OF A LASER-PRODUCED PLASMA. Ivanov, Yu. S.; Ryukkert, V. V.; Skliz-kov, G. V.; Fedotov, S. I. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1132-6 (Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1423-8(Jul 1972).

The parameters of a pulsed x-ray source intended for diagnostics of a laser-produced plasma with temperatures from 10^6 to 10^8°K are estimated. An x-ray source with a focal diameter of 0.2 mm and pulse length of 10^{-9} sec is described. The pulsed intensity of this source at a voltage of 11 kV is 3×10^8 photons over the total solid angle. (auth)

Kinetics (General)

Refer also to abstracts 10246 and 10342.

11104 (AE-460) IONIZATION OF A HIGH-PRESSURE GAS FLOW IN A LONGITUDINAL DISCHARGE. Palmgren, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Nov 1972. 20p. Dep. NTIS (U. S. Sales Only).

Some aspects of the cathode fall of a discharge in a longitudinal high-pressure gas flow are examined. The primary cathode fall close to the electrode is not considered here but a description of electron density and potential profile in a layer close to the fully developed positive column is given. The departure from equilibrium is explained in terms of ionization and recombination, diffusion, and electron heat conduction effects. Of special interest is how convection influences this layer. The layer is treated in a one-dimensional and quasi-neutral approximation. Numerical results for flowing helium at atmospheric pressure are presented. (auth)

11105 (AEC-tr-7383) THETA PINCH IN AN ELECTRON-HOLE PLASMA WITH SURFACE GENERATION. Vladimirov, V. V.; Kozlovskaya, N. N.; Shanskii, V. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Leningrad). Translated from report NP-19269. 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 26: 32516. (M.O.W.)

11106 (UCRL-51275) CURRENT CTR COMPUTER CODES IN USE AT LAWRENCE LIVERMORE LABORATORY. Byers, J. A.; Killeen, J. (comps.) (California Univ., Livermore. Lawrence Livermore Lab.). 12 Sep 1972. Contract W-7405-eng-48. 27p. Dep. NTIS.

The attached compilation is a list of the major computer codes (programs) currently used in CTR research at the Lawrence Livermore Laboratory. A brief description of each code is included. The codes listed here either exist in fully developed form or are in a state of active development. Many of those which are complete are being actively modified to include new effects. (auth)

11107 PLASMA FLUX TRANSPORT IN MAGNETIC FIELDS UP TO 100 kOe. Gabovich, M. D.; Starchik, P. D.; Semenyuk, V. F. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 353-5(Mar 1972). (In Russian).

The broadening of a helium or argon plasma flux with $n \approx 5 \times 10^{12}$ cm^{-3} was determined during plasma outflows in a vacuum region along the magnetic field up to 100 kOe. It is shown that the plasma flux may propagate, practically without broadening, in such magnetic fields. (auth)

11108 POLARIZATION INTERACTION OF PLASMA FLOWS IN TRANSVERSE MAGNETIC FIELD. Volkov, Ya. F.; Dyatlov, V. G.; Mitina, N. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 922-7(Jun 1972). (In Russian).

It is shown that plasma flows slow down in the polarization interaction without penetrating into each other. In this case, the energy of the transverse ion motion in the flow becomes high (30 eV) as compared with the transverse flow without polarization interaction. When there is no current in the lines along which the plasma flows, the transverse energy is equal to 10 eV. (auth)

11109 EQUALITY OF ABSORPTION AND EMISSION LINE SHAPES FOR THE STARK BROADENED He II RESONANCE LINE IN A HELIUM PLASMA. Burgess, D. D.; McIlrath, T. J. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 5: No. 10, L220-3(Oct 1972).

The recent contention of Griem (Comments Atom. Molec. Phys., 3: 1-3(1972)) that there can be a difference between emission and absorption shapes of Stark-broadened lines in a thermal plasma is shown to be in error, as in his assertion that "symmetrization" effects reduce the line-width of the helium resonance line in a helium plasma. (auth)

11110 ELECTRON ENERGY DISTRIBUTION IN A LOW-TEMPERATURE PLASMA. Lyagushchenko, R. I. (Leningrad State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 901-9(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1130-42(Jun 1972).

An approximate solution is given for the electron energy distribution in a low-temperature plasma formed from an atomic gas for an arbitrary ratio between the electron–electron collision frequency and the frequency of elastic and inelastic collisions with atoms. The results hold for a variety of functional relations between the collision frequency and energy. Conditions for the applicability of results are $T_e \ll \epsilon_1$ and $f_0(\epsilon_1) \ll f_0(T_e)$, where T_e is the electron temperature, ϵ_1 is the threshold energy for atomic excitation, and $f_0(\epsilon)$ is the energy distribution function. (auth)

11111 POLARIZATION INTERACTION OF OPPOSED PLASMA STREAMS IN A LINEAR MAGNETIC OCTUPOLE. Berezov, D. V.; Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 963-8(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1212-18(Jun 1972).

The polarization interaction in opposed plasma streams, characteristic of the filling of a toroidal multipole, was simulated in a linear octupole. The plasmoids are generated by conical plasma sources and propagate in opposite directions along the axis of the multipole field. Because of the opposite polarization of the interacting jets, the polarized multipole electric field is cancelled in the plasma. Two regions, in which depolarization currents flow in opposite directions, are distinguished. The depolarized plasma moves along the normal to the magnetic surface both in the direction of the walls and in the direction of current-carrying conductors. (auth)

11112 FORMATIVE PHASE OF A LOW PRESSURE, HIGH VOLTAGE Z PINCH. Maclatchy, C. S.; Barnard, A. J. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 20, 2475-81(15 Oct 1972).

The formative phase of a 40-kV z pinch was investigated for pressures from 10 to 80 mtorr in H_2. The energy spectrum of the electrons on the axis of the vessel, the spatial distribution of the current at the face of the anode, and the total discharge current were monitored. At the initiation of the discharge, a current of electrons with energies in excess of 20 keV is observed on the axis. This observation is in contrast to the normally accepted mode of ionization in which ionization initiates at the wall. The current is observed to switch from the axial region to the wall where it forms a current layer which collapses in accordance with the snowplough model. The exact nature of the switching mechanism is not understood. The formative phase of the pinch typically takes a few hundred nanoseconds. The observations indicate that the detailed process of current sheet collapse may be affected by the formative phase. (auth)

11113 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. VYPUSK 3. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis. Number 3). Tolok, V. T. (ed.). Kiev; Naukova Dumka (1972). 228p.

A total of 21 papers on the physics of plasmas by different authors comprise this book which presents the results of theoretical and experimental investigations on the subtopics of beam–plasma interactions, high-frequency properties, magnetic traps, and plasma instability problems. (K.S.W.)

Kinetics (Experimental)

11114 PLASMA POLARIZATION SHIFT OF THE RESONANCE LINES OF IONIZED HELIUM. Volonte, S. (Culham Lab., Abingdon, Eng.). Space Sci. Rev.; 13: No. 4-6, 528-30 (1972).

Measurements were made of the plasma polarization shift of the resonance lines of ionized helium using a low-inductance T-type shock tube. The experimental apparatus is described, and the plasma density and temperature were derived from the width and the line-to-continuum ratio of the 4686 He^+ line. The shifts were measured from the microdensitometer traces of the lines of interest. The plasma conditions in the experiment were $N_e \approx$

9×10^{17} cm^{-3} and $T_e \simeq 45000$ K. The first two members of the resonance series, λ304 Å and λ256 Å, were analyzed. No conclusions are formed for the 304-Å line, but a red shift of 0.032 Å was measured for the 256-Å line. (J.C.W.)

11115 MEASUREMENTS OF COLLISIONAL RATE COEFFICIENTS IN LABORATORY PLASMAS. Kunze, H. J. (Univ. of Maryland, College Park). Space Sci. Rev.; 13: No. 4-6, 565-83 (1972).

Line radiation emitted by highly ionized atoms embedded in hot laboratory plasmas can be utilized to obtain collisional rate coefficients for excitation and ionization. After a discussion of the principles underlying these measurements, the plasma device mostly used is explained briefly as are the various experimental techniques. All experimental results obtained so far are discussed and compared with theoretical calculations where possible. (70 references) (auth)

11116 RELATION BETWEEN LASER FLUX, TEMPERATURE, AND IONIZATION EQUILIBRIUM IN LASER-PRODUCED PLASMAS. Key, M. H.; Hutcheon, R. J.; Preston, D. A.; Donaldson, T. P. (Queen's Univ., Belfast). Space Sci. Rev.; 13: No. 4-6, 584-5(1972).

An experiment was carried out in which a 2-GW, 15-nS pulse of neodymium laser radiation, of known power, was focused on a solid target. The flux density at the target was obtained from photographic measurements on a highly magnified image of a duplicate focal spot formed by a beam splitter and identical lens. The plasma temperature was obtained from foil absorption measurements and the highest stage of ionization from the xuv spectrum. The measured plasma temperatures are plotted against the laser power. These points can be represented by the relation temperature $\propto$ (power)^x where $0.66 \leq x \leq 0.75$. Some of these points are plotted in terms of laser flux and compared with theoretical models. Knowledge of the dependence of plasma temperature on incident laser flux should lead to estimates of the degree of ionization obtained. However, such estimates should allow for the possibility of ions leaving the dense plasma region before the ionization equilibrium appropriate to the plasma temperature is reached. Theoretical estimates suggest that, for the laser conditions used, this effect might influence the ionization equilibrium of hydrogenic ions with Z = 8 or higher. However, the experimentally determined threshold temperature for observation of both O VIII and F IX ions is 280 ± 70 eV. This temperature agrees with that required in a steady-state plasma. (J.C.W.)

11117 SEPARATION OF PLASMA MOVING AT AN ANGLE TO THE AXIS OF A COAXIAL SOURCE. Belikov, A. G.; Goncharenko, V. P.; Goncharenko, D. K.; Derepovskii, N. T. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 1057-8(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1325-7(Jun 1972).

It was demonstrated experimentally that a plasmoid moving at an angle to the axis of a source can be separated if a large chamber is available. The parameters are given for such a plasmoid and it is shown that for small angles these are not very different from the parameters of a plasmoid moving along the axis of the source. It is pointed out that several identical fast plasmoids could be obtained simultaneously. (auth)

11118 ROLE OF TURBULENCE IN THE COUPLING OF A MAGNETIC PULSE TO A COLLISIONLESS PLASMA. Davis IV, W. D. College Park, MD; Univ. of Maryland (1972). 117p. University Microfilms Order No. 72-29,429.

Thesis.

The coupling of a magnetic pulse to an initially magnetized collisionless plasma was experimentally studied, using a high-voltage theta pinch. It was found that when the initial magnetic field is parallel to the magnetic field of the pulse (parallel case), the acceleration of the plasma can be explained almost entirely by the $\vec{J} \times \vec{B}$ force where the current density $\vec{J}$ is limited by a turbulent resistivity. When the initial magnetic field is antiparallel to the magnetic field of the pulse (antiparallel case), a strong particle pressure gradient is found to exist near the field reversal point. The plasma acceleration in this case is produced by the combination of the particle pressure gradient and the $\vec{J} \times \vec{B}$ force. The current density $\vec{J}$ is again limited by turbulence. The plasma turbulence was investigated in both parallel and antiparallel cases by electric probes and the helium satellite-line technique. Electron cyclotron waves and ion plasma waves are identified in the antiparallel case, while electron plasma waves and ion plasma waves are identified in the parallel case. It is concluded that no single instability mechanism can explain the measured electron and ion heating, turbulent field level, turbulent field spectrum, and plasma resistivity. (Diss. Abstr. Int., B)

Kinetics (Theoretical)

Refer also to abstract 11156.

11119 EXISTENCE OF A TWO-DIMENSIONAL CLASSICAL PLASMA. Gonzalez, J. J.; Hemmer, P. C. Ark. Fys. Seminar Trondheim; No. 13, 5p(1972).

The existence of the partition function of a classical plasma for temperatures above a critical value T_c is proved. The convergence of the configuration integral is proved by an inequality which shows that, physically speaking, coalescing in many-particle clusters is not more singular than formation of a neutral pair. This is valid for all dimensions, and the existence of the partition function of a two-dimensional plasma having N positive and N negative particles is also proved. (Norway)

11120 DIFFUSION TIME OF CHARGED PARTICLES IN A PLASMA WITH VOLUME IONIZATION. Gurin, A. A.; Pasechnik, L. L.; Popovich, A. S. (Inst. of Nuclear Research, Kiev). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 889-93(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1113-19(Jun 1972).

A method for calculating the mean diffusion time of "test" charges from the source to the collector is proposed in a confined plasma with volume ionization. The method is based on the theory of diffusion processes with volume multiplication and surface absorption. It is shown that the times thus determined can be measured experimentally by the "phase method." Calculations for infinite-length cylindrical systems make it possible to determine from these measurements the coefficients of diffusion across the magnetic field and the ionization rate in the plasma. (auth)

11121 NONLINEAR EFFECTS IN PLASMA. Tsytovich, V. N. New York; Plenum Publishing Corporation (1970). 347p. $25.00.

Translation of Nelineinye Effekty v Plazme by J. S. Wood.

The following chapters are included: (1) nonlinear effects and plasma physics, (2) weak nonlinearities in cold plasma, (3) nonlinear interaction of three wave packets, (4) induced processes in plasma, (5) general characteristics and applications of decay processes in plasma, (6) induced emission of waves by plasma particles, (7) induced scattering of waves by plasma particles, (8) induced scattering of electromagnetic waves in an isotropic plasma, (9) applications of induced wave scattering in plasma, and (10) current trends in research on nonlinear effects in plasma. (224 references) (M.O.W.)

11122 FLUCTUATIONS IN GUIDING CENTER PLASMA IN TWO DIMENSIONS. Taylor, J. B. (United Kingdom Atomic Energy Authority Research Group, Abingdon, Eng.); Thompson, W. B. Phys. Fluids; 16: No. 1, 111-17(Jan 1973).

Statistical mechanics is developed for a two-dimensional guiding center plasma. Because there is no kinetic energy associated with guiding center motion, this development is unconventional. Thermal equilibrium is discussed, and an interesting limiting case is noted. Using the random phase assumption, a kinetic equation for the density fluctuations is obtained, which has thermal equilibrium and its limiting form as the only stationary states. However, despite the phase averaging this kinetic equation is reversible and when disturbed the system oscillates about equilibrium. Similar oscillatory behavior appears in the microscopic correlation function of the fluctuations, and the oscillation frequencies are obtained explicitly; however, these oscillations do not significantly change the macroscopic diffusion coefficient derived earlier by McNamara and Taylor. (auth)

11123 EFFECT OF VELOCITY DEPENDENCE OF COULOMB LOGARITHM ON THE SOLUTION OF THE FOKKER–PLANCK EQUATION. Cooper, G. E.; Herman, P. T. (Univ. of California, Livermore). Phys. Fluids; 16: No. 1, 118-21(Jan 1973).

The error incurred through the customary neglect of the velocity dependence of the Coulomb logarithm was evaluated by reexamining the problem of the deceleration of a test particle in a plasma. Numerical results indicate that a neglect of this velocity dependence results in an underestimation of the energy deposited by a test particle in the ion field of a plasma. (auth)

11124 RELAXATION OF ANISOTROPIC COLLISIONLESS PLASMA. Hamasaki, S. (Cornell Univ., Ithaca, NY); Krall, N. A. Phys. Fluids; 16: No. 1, 145-9(Jan 1973).

The relaxation of anisotropic collisionless plasma distributions due to whistler mode instabilities is calculated through quasi-linear theory, for various values of background magnetic field strength. The results are compared with previous computer simulation experiments and with the predictions of classical (collision-dominated) transport theory. (auth)

11125 STEADY-STATE CHARGED- AND NEUTRAL-PARTICLE DENSITIES IN A BOUNDED TURBULENT HIGH-TEMPERATURE PLASMA. Kitainer, A. G.; Sholin, G. V. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1123-7(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1413-18(Jul 1972).

The spatial distribution of electron, ion, and neutral atom densities is determined for a steady-state turbulent plasma. It is assumed that diffusion is the basic mechanism for particle loss from the volume and that the mean free path of atoms for ionization, charge exchange, and elastic scattering is greater than the transverse dimension of the system. It is shown that the neutral atom density N_0 varies slightly over the cross section, with the average value of N_0 being related to the ionization and diffusion coefficients. The results are in good qualitative agreement with experiment and can be used for more precise measurements of diffusion coefficients in closed systems. (auth)

Production

11126 (LA-5086) LASER PULSE PROPAGATION THROUGH IONIZABLE MEDIA. Henderson, D. B. (Los Alamos Scientific Lab., N. Mex.). Dec 1972. Contract W-7405-eng-36. 20p. Dep. NTIS.

The self-unfocusing of an intense laser pulse due to an ionizable atmosphere is studied. Computer codes are developed and applied to cases of interest to laser-fusion power reactors. Self-unfocusing is found to place a significant limit on the background density, the final impact of which must await further study. (auth)

11127 ION AND VELOCITY STRUCTURE IN A LASER-PRODUCED PLASMA. Irons, F. E.; McWhirter, R. W. P.; Peacock, N. J. (United Kingdom Atomic Energy Authority Research Group, Abingdon, Eng.). J. Phys., B (London); 5: No. 10, 1975-87(Oct 1972).

The early expansion of the plasma produced by the laser irradiation of a polyethylene foil in vacuum was studied by making time-resolved observations at right angles to the target normal. Spectral line emission was scanned to give the spatial distribution of the ion species carbon I–VI. The lines observed are Doppler broadened by the ion streaming motion, and this broadening was interpreted to give velocity as a function of time and of distance from the target normal. For one ion species (carbon V) a reconstruction was made of the ion trajectories. Velocities of 2 to 3×10^7 cm s^{-1} were deduced from Doppler shifts observed parallel to the target normal and are in agreement with previous time-of-flight measurements. (auth)

Stability

11128 (EUR-CEA-FC-634) STUDY OF THE EQUILIBRIUM AND THE STABILITY OF A TOROIDAL PLASMA IN DIFFERENT CROSS SECTIONS BY THE NUMERICAL SOLUTION OF THE EQUILIBRIUM MHD EQUATION. Gourdon, C.; Touche, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jul 1972. 44p. (In French). Dep. NTIS (U. S. Sales Only).

The MHD equilibrium of an axially symmetric toroidal plasma in a Tokomak configuration is studied for ring cross sections of different shapes and aspect ratios. The equilibrium equation is solved numerically using the finite difference method with a two dimensional mesh and various boundary conditions. The maximum current and the maximum beta value obtained are given for each case, the MHD stability criterion perturbations being taken into consideration. (France)

11129 (IAE-2171) SUPPRESSION OF FLUTE INSTABILITY BY INTEGRATED FEEDBACK. Chuyanov, V. A. (Institut Atomnoi Energii, Moscow (USSR)). 1972. 28p. (In Russian). Dep. NTIS (U. S. Sales Only).

Experiments on the suppression of flute instability in the Phoenix-2 device by integrated feedback are described. Numerical calculations of the frequency characteristics of the reverse feedback system showed that the introduction of integrated feedback removed the amplifier instability and brought about a 30-fold decrease of oscillation amplitude and an 8-fold increase in the threshold density of the formation of flute instabilities. (tr-auth)

11130 (KHFTI-71-3) STUDY OF THE INSTABILITY OF A NONHOMOGENEOUS COLLISIONAL PLASMA OF FINITE PRESSURE. Nemov, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 29p. (In Russian). Dep. NTIS (U. S. Sales Only).

The drift instability of a magnetized, nonhomogeneous completely-ionized plasma was theoretically investigated on the basis of hydrodynamic equations for transport. The gas-kinetic pressure of the plasma was of the same order or larger than the magnetic pressure. The heat exchange between electrons and ions and the thermal conductivity along the magnetic field were computed from dissipation effects. The increments in the excitation increase and the limits of the instability region were established. For $\beta \gg 1$, the instability may develop at significantly higher values of K_z than for $\beta \leq 1$. Here $\beta = 8\pi p/B^2$, p = the gas-kinetic pressure, B = the absolute value of the intensity of the magnetic field, and K_z = the component of the wave vector along $\vec{B}$. Therefore stabilization of gradient instabilities may be more difficult for $\beta \gg 1$ than for $\beta \leq 1$. (tr-auth)

11131 ELECTROMAGNETIC RADIATION CAUSED BY THE TWO-STREAM INSTABILITY IN A BOUNDED PLASMA. Aronov, B. I.; Rukhadze, A. A.; Chogovadze, M. E. (Lebedev Inst. of Physics, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 877-81(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1097-1103(Jun 1972).

The excitation of electromagnetic waves by a relativistic electron beam in a plasma-filled metal waveguide is studied. It is shown that quasilongitudinal waves have the maximum growth rate. The quasilinear relaxation of pure longitudinal waves of a monoenergetic relativistic electron beam in a bounded plasma is analyzed; this relaxation leads to a spreading of the beam velocities, a Maxwellian distribution being established with an anisotropic temperature. The time for quasi-linear relaxation, the velocity distribution of the beam electrons, and the amplitude of a steady-state longitudinal wave are determined. This result makes it possible to estimate the amplitude of steady-state nonlinear electromagnetic waves in a plasma in which the two-stream instability develops and to calculate the Poynting flux. (auth)

11132 STATIONARY TURBULENCE OF A PARAMETRICALLY UNSTABLE PLASMA. Pustovalov, V. V.; Silin, V. P. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 5, 216-19(5 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 5, 308-11(5 Sep 1972).

The developments of concepts concerning the turbulent state produced in the plasma during the evolution of the parametric instability are discussed. The results obtained to date in the theory of stationary turbulence are connected with allowance for the nonlinear interaction of the growing plasma perturbations, this interaction being due to stimulated scattering of the waves by the particles. The stimulated scattering of waves by particles is not the only nonlinear process of interaction between waves and plasma particles in the same approximation of the expansion in powers of the plasma-fluctuation intensity. It is noted that the nonlinear frequency shift of the plasma oscillations plays an important role in the establishment of the stationary turbulence level of a parametrically unstable plasma. The stabilizing effect of such a frequency shift is demonstrated using as an example aperiodic parametric instability, which, unlike the instability of the type of Raman scattering, or, which is the same, the decay of the pump wave into a hf plasma wave and a lf ion-acoustic wave, has apparently a more universal significance. (J.C.W.)

11133 PROPERTIES OF A LOW-FREQUENCY INSTABILITY IN A HOLLOW-CATHODE-DISCHARGE MAGNETOPLASMA. Kambic, G. X. Troy, NY; Rensselaer Polytechnic Inst. (1972). 150p. University Microfilms Order No. 72-30,214.

Thesis.

A low-frequency drift instability, driven by plasma density and potential gradients, was studied in a plasma with electron temperatures ~5 eV and charged particle densities $\sim 5 \times 10^{13}$ cm^{-3}. The instability was examined experimentally for dependence on magnetic field, neutral gas pressure and gas flow rate into the discharge. Particular emphasis was placed on the phase difference between the potential and density oscillations associated with the instability. A theoretical model using the two fluid equations was developed. In the first stage the electron oscillations were assumed to be in phase with the potential oscillations. The resulting dispersion relation was $\omega \approx k_y v_d$, where ω is the wave frequency and v_d is the diamagnetic drift velocity of the ions. This did not agree with experiment. However, a phase relationship between density and potential oscillations derived from this dispersion relation, gave good agreement between the measured and calculated phase angle, as a function of $\alpha_i = \nu_i/\omega_{ci}$ where ν_i is the effective ion collision frequency. Best agreement was obtained when ν_i was permitted to vary as a function of radius. Density was predicted to lead potential, in agreement with experiment. A second approximation, including the electron phase terms, gave reasonable agreement between the calculated and measured dispersion relations. However, the phase calculation in

this case predicted only that the density oscillations would lead the potential oscillations. No quantitative agreement was found overall. (Diss. Abstr. Int., B)

11134 DYNAMIC STABILIZATION OF PLASMAS BY MEANS OF A HIGH-FREQUENCY-MODULATED ELECTRON BEAM. Aghevli, R. Ann Arbor, MI; Univ. of Michigan (1972). 199p. University Microfilms Order No. 72-28,987.

Thesis.

The stabilizing effects that a beam of longitudinally nonuniform density imposes on beam–plasma instabilities are studied. Particular attention is directed to the stabilization of convective instabilities, which are among the most dominant beam–plasma instabilities over the entire frequency spectrum. An infinite beam-infinite plasma geometry is chosen to represent the system for the one-dimensional case (corresponding to an applied static magnetic field of infinite value). A beam–plasma system is considered in two dimensions with either a zero or finite static axial magnetic field. The plasma is assumed to be either infinite or bounded by a perfectly conducting cylindrical waveguide. A cylindrical electron beam is assumed to be concentric with the plasma column with a radius smaller than that of the plasma column. The hydrodynamic model is adopted for both the beam and the plasma with ac perturbations of sufficiently small magnitude to allow linearization. The weak turbulence approximation is also made in the course of the analysis. The plasma is assumed to be uniform, whereas the beam is to be characterized with either of two types of longitudinal inhomogeneity — rectangular or sinusoidal. (TSS) (Diss. Abstr. Int., B)

11135 PRIVILEGED EQUILIBRIA OF A COLLISIONLESS HOMOGENEOUS OR INHOMOGENEOUS PLASMA. Minardi, E. (EURATOM-FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). Phys. Fluids; 16: No. 1, 122-9(Jan 1973).

A statistical method for describing the collisionless (in general non-Maxwellian) equilibria and the stability of inhomogeneous Vlasov plasmas is proposed and applied to various electrostatic cases. By means of this method the entropy and the other thermodynamic potentials can be calculated. The entropy principle allows the calculation of the electrostatic equilibria which are preferably chosen by the plasma. It is shown that the Bernstein–Greene–Kruskal sinusoidal wave is a maximum of the entropy provided dissipative processes are neglected. Examples are given of the general property of a collisionless system to evolve toward the marginal stability point. In one example the evolution of a bump-in-tail distribution toward a plateau is easily shown. It also follows from the theory that the collisionless dissipative processes always imply the excitation of short wavelength modes. (auth)

11136 LARGE-AMPLITUDE STABILIZATION OF THE DRIFT INSTABILITY. Ching, H. (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids; 16: No. 1, 130-9(Jan 1973).

A general mechanism of large-amplitude stabilization of the drift instability is investigated. For slab geometry, a drift-wave potential of the form $\phi = \Phi \cos(k_x x) \cos(k_y y + k_z z - \omega t)$ is used where x is the direction of plasma density inhomogeneity and z is the direction of a uniform field. It is assumed that $k_x \sim k_y \gg k_z$ and $v_i \ll \omega/k_z \ll v_e$. Studies of the exact guiding-center particle trajectories in the drift-wave potential show the existence of time-average, y-direction velocities whose magnitudes increase with the amplitude of the drift wave. As the wave grows, these velocities shift parts of the resonance region away from $v_z = \omega/k_z$ and finally into the bulk of the ion distribution. Thus, the original instability is stabilized by strong ion Landau damping. Stabilization will occur around the wave amplitude satisfying the condition, $ck_x\Phi/B = \omega/k_y$. (auth)

11137 NON-MAXWELLIAN TOROIDAL EQUILIBRIA WITH SPHEROIDAL PLASMA–VACUUM INTERFACES. Dobrott, D. (Gulf General Atomic Co., San Diego, CA); Morikawa, G. K. Phys. Fluids; 16: No. 1, 140-4(Jan 1973).

Axially symmetric toroidal plasma equilibria with spherical or near-spherical plasma–vacuum boundaries are examined when variations in the distribution function produce anisotropic pressures. A separable analytic solution is found when the pressure deviation from isotropy is small; the degree of anisotropy is used as an expansion parameter in the perturbation scheme. In general, the plasma–vacuum boundaries deform slightly and spherical boundaries cannot be maintained by externally applied fields that remain finite at large distances. When $p_\perp > p_\parallel$, the plasma becomes a prolage spheroid and when $p_\parallel < p_\perp$ it becomes oblate. (auth)

11138 PRESSURE LIMITATION IN A SIMPLE MODEL OF A TOKAMAK. Haas, F. A.; Thomas, C. Ll. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids; 16: No. 1, 152-5(Jan 1973).

The simple model of a tokamak studied by Strauss is reinvestigated. By defining poloidal β to be the ratio of the integrated pressure to the square of the toroidal current, it is shown that this quantity is bounded. (auth)

11139 PARAMETRIC EXCITATION OF LOWER HYBRID INSTABILITIES. Kaw, P. K.; Lee, Y. C. (Princeton Univ., NJ). Phys. Fluids; 16: No. 1, 155-7(Jan 1973).

The application of a sufficiently intense long-wavelength oscillating electric field at the lower-hybrid frequency to a plasma with two ion species leads to instability of finite-wavelength electron–ion lower-hybrid modes and a purely growing modification of the ion–ion hybrid mode. (auth)

11140 INSTABILITY OF A MAGNETOACTIVE PLASMA WITH A TRANSVERSE ION BEAM. Machabeli, G. Z.; Tskhakaya, D. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1072-5(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1343-7(Jul 1972).

A distribution function is formed to represent a transverse ion beam. The longitudinal dispersion relation is obtained. A cold plasma is found to be unstable at multiples of the ion gyrofrequency, and the growth rate is given. (auth)

11141 HIGH-FREQUENCY INSTABILITIES IN A PLASMA WITH A NONLINEAR ION-ACOUSTIC WAVE. Aref'ev, V. I.; Kirdyashev, K. P. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1083-9(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1357-65(Jul 1972).

Plasma experiments on the excitation of a high-frequency instability with a large-amplitude ion-acoustic wave are described. The experiments are carried out in a plasma formed by an electron beam under conditions of weak beam–plasma interaction. A theoretical model based on two-stream motion of the electrons in the field of the low-frequency wave leads to a high-frequency instability. The conclusions of the theory are in broad agreement with the experimental results. (auth)

11142 QUASI-LINEAR PARTICLE ACCELERATION IN A HYDRODYNAMIC CYCLOTRON INSTABILITY. Kulygin, V. M.; Tsapelkin, E. S. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1090-4(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1366-72(Jul 1972).

The quasi-linear relaxation of a group of fast particles that excite a hydrodynamic cyclotron instability in a cold plasma is analyzed. The system of quasi-linear equations is solved numerically with a computer. The relaxation process and the development of the oscillation spectrum are followed. It is shown that the quasi-linear equations are applicable in this case. The problem is of interest, for example, in the capture of fast ions produced by ionization of a neutral beam in a magnetic trap. (auth)

11143 CURRENT-DRIVEN INSTABILITIES IN A STRONGLY INHOMOGENEOUS PLASMA. I. Aref'ev, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1095-1102(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1373-84(Jul 1972).

Current-driven stabilities in the strongly inhomogeneous plasma in the anode sheath of a self-maintained discharge in a strong transverse magnetic field are analyzed. The limiting currents for high-frequency electrostatic oscillations in the anode sheath are determined. Turbulent heating of electrons and ions is considered in the quasi-linear approximation. The self-consistent problem of potential and density distribution of the oscillation energy in the current sheath is solved in the hydrodynamic approximation. (auth)

11144 FORMATION OF DOUBLE LAYERS IN PLASMAS. Carlqvist, P. (Royal Inst. of Tech., Stockholm). Cosmic Electrodyn.; 3: No. 3, 377-88(Oct 1972).

A homogeneous plasma carrying a constant current is considered. It is demonstrated that the plasma is unstable if the current density exceeds a critical value that depends both on the plasma density and on the thermal energies of the ions and of the electrons in the plasma. A small one-dimensional disturbance in the form of a density dip will then give rise to a progressive local evacuation of the plasma. When the particle density in the dip has been reduced to a certain limit, a double layer forms in the evacuated region. The stability of such a double layer is briefly discussed. The occurrence of double layers in the ionosphere and in the solar atmosphere is considered. (28 references). (auth)

11145 CURRENT-DRIVEN INSTABILITIES IN A STRONGLY INHOMOGENEOUS PLASMA. II. Aref'ev, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1103-7(Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1385-92(Jul 1972).

The most dangerous transverse-current instabilities of the anode sheath of a self-maintained discharge that sharply increase the transverse mobility of electrons and result in turbulent ion heating

are discussed. The current sheath structure is analyzed taking account of microscopic turbulence caused by unstable ion-acoustic waves and ion–ion instabilities. Turbulent plasma heating is analyzed. It is shown that, as a result of quasi-linear relaxation, the current front has a steep step structure and the entire electron drift current can be forced out into the steep front domain. (auth)

Thermonuclear Engineering and Equipment

Refer also to abstract 9448.

11146 (CONF-721109–9) ENVIRONMENTAL ASPECTS OF FUSION POWER PLANTS. Fraas, A. P. (Oak Ridge National Lab., Tenn.). 1972. 17p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

There is a tremendous incentive to develop fusion power, and, if plants of the type envisioned can be developed, they should provide the basis for essentially eliminating air, water, and thermal pollution as well as most of the land despoilment currently associated with mining operations for power plants. The power resulting from this type of plant should be cheap and the fuel reserves adequate for the life of our Sun. In short, from the long-range point of view, the development of fusion power plants appears to be eminently worthwhile. (auth)

11147 (COO–3170-1) THEORETICAL STUDIES ON ASTRON STABILITY. Progress Report, January 1, 1972–December 31, 1972. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 1972. Contract AT(30-1)-3170. 125p. Dep. NTIS.

Separate abstracts were prepared for the three individual papers. (M.O.W.)

For abstracts of individual papers see: 11081, 11148, and 11149.

11148 (COO–3170-1(Paper 1)) ELECTROSTATIC PRECESSIONS. Condit, W. C. Jr.; Lovelace, R. V. (Univ. of California, Livermore). Nov 1972. 8p. (LPS–107).

In Theoretical studies on astron stability.

The precessional motion of an un-neutralized E layer due to image charges on the walls of the Astron tank is computed. The layer is treated as an infinitely long and rigid cylinder (after Berk and Sudan, UCRL-72754). Its axis is taken as displaced an amount ϵ from the axis of the conducting tank, and the parameted ϵ/ρ_0 is taken as small, where ρ_0 is the E-layer equilibrium radius. Under the assumption of rigid or coherent precessions, only the motion of a single typical particle need be computed, and the full relativistic equations for such a particle are solved to first order in ϵ/ρ_0. The results indicate that the electrostatic precessions of the E layer occur at a much higher frequency than the magnetic precessions that have been observed after the E layer is neutralized. (auth)

11149 (COO–3170-1(Paper 2)) ASTRON E-LAYER EQUILIBRIA FORMED BY INJECTION. Lovelace, R. V.; Fessenden, T. J.; Sudan, R. N.; Fleischmann, H. H. (Cornell Univ., Ithaca, NY). Aug 1972. 39p. (LPS–90).

In Theoretical studies on astron stability.

Collisionless equilibria of long but finite-axial-length E-layers formed by the injection and trapping of relativistic electrons are considered. The conservation of canonical angular momentum under the condition of axial symmetry provides the basic relation connecting the injection parameters to properties of the equilibria. The possible equilibria compatible with the canonical angular momentum conservation are discussed (without restriction to the case of layers of small radial thickness). The further constraints on these equilibria imposed by the balance of axial pressure and overall energy conservation are considered. (auth)

11150 (LA–5087) REVERSIBLE MAGNETIC ENERGY TRANSFER AND STORAGE SYSTEMS. Thomassen, K. I. (Los Alamos Scientific Lab., N. Mex.). Nov 1972. Contract W-7405-eng-36. 11p. Dep. NTIS.

A superconducting energy transfer and storage system to supply the compression magnetic field pulse for the theta pinch reactor is discussed. Each module, which supplies a section of the reactor, uses three nested spherical coils, two of which are in quadrature and rotate with respect to the third, and a transformer to couple energy out. An optimum design transfers 62% of the energy to the coil and back. Design parameters and cost estimates are given. (auth)

11151 (ORNL-TM–4023) EXPLICIT EXPRESSION FOR THE MAGNETIC FIELD DUE TO A CURRENT LOOP. McNeilly, G. S. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 10p. Dep. NTIS.

An explicit formula for the magnetic field due to a current loop is given in terms of complete elliptic integrals. Since in many cases a current loop or loops is a close approximation to a finite circular coil, the expression is useful in magnetic field calculations involving circular coils. A program which calculates the expression is included in the appendix. (auth)

11152 (SC-RR–720473) USING PULSE LINES FOR DRIVING GAS SHOCK-HEATED D-T FUSION SYSTEMS. Freiwald, D. A. (Sandia Labs., Albuquerque, N. Mex.). Nov 1972. 65p. Dep. NTIS.

The power and energy requirements for producing dense ($\geq 10^{19}/cm^3$) high-temperature (~10 keV) D–T plasmas via magnetic pistons in laboratory experiments are investigated. It is shown that one must operate at power levels the order of Terawatts (10^{12}) over times the order of a few tens of nanoseconds into impedances the order of one tenth to one ohm. In this context, the concept of applying electron beam machine technology is considered, namely, using a Marx capacitor system to charge pulse lines (high-density energy storage) which in turn drive pulsed fusion experiments. Current state of the art limits are discussed. (auth)

11153 RESONANT PHENOMENA IN TOROIDAL CONFIGURATIONS WITH A SCREW MAGNETIC AXIS. Demchenko, V. V.; El-Naggar, I. A.; Hussein, A. M. (Atomic Energy Authority, Cairo). Phys. Lett.; 42A: No. 3, 208-10(4 Dec 1972).

It is demonstrated that, taking into account the toroidal shape of magnetic systems designed for plasma confinement, under certain conditions one can expect a resonant increase of the magnetic line-of-force coordinate. This phenomenon, comparable to the effect of a parametric instability, causes the disruptance of closed magnetic surfaces and might be a serious hazard to the operation of toroidal tokomak-type systems. (auth)

11154 PRODUCTION OF LARGE HYDROGEN CLUSTERS IN CONDENSED MOLECULAR BEAMS. Klingelhoefer, R.; Moser, H. O. (Univ., Karlsruhe, Ger.). J. Appl. Phys.; 43: No. 11, 4575-9(Nov 1972).

Intense hydrogen-cluster beams having velocities of about 500 m/sec can be produced by expansion of precooled hydrogen gas out of a nozzle into high vacuum. They are of interest for the compensation of particle losses in thermonuclear devices. The dependence of the penetration depth into the plasma on the velocity and the size of the clusters is still unknown. In order to study the influence of the latter the available beams should cover a range of cluster size as wide as possible. Using a cryostat which can be operated at temperatures above the critical one, the range has been extended by about three orders of magnitude up to a mean size of about 10^9 H atoms per cluster. The cluster sizes have been determined by light-scattering technique. This method is particularly useful during the injection of cluster beams into a plasma. (auth)

Wave Phenomena

11155 (CEA-CONF–2039) LOWER-HYBRID OSCILLATION SPECTRUM. Pesic, S. S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 4p. (CONF-720725–1). Dep. NTIS (U. S. Sales Only).

From Symposium and summer school on the physics of ionized gaze; Belgrade, Yugoslavia (16 Jul 1972).

The lower-hybrid oscillation spectrum of a low-pressure homogeneous plasma with Maxwellian distributions of electrons and ions confined by a uniform magnetic field is considered. It is assumed that the fields vary with a characteristic time that is smaller than the energy-relaxation time and that the energy of the considered waves is considerably smaller than the particle thermal energy. Linearized solutions are found for plane waves. (M.O.W.)

11156 KINETIC THEORY OF FLUCTUATIONS IN A PLASMA HALF-SPACE. Genchev, Zh. D.; Kalmykova, S. S. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 3, 448-58(Mar 1972). (In Russian).

Theoretical considerations are given of the fluctuations of the electromagnetic field in an isotropic plasma half-space with specular reflection of electrons from a plasma boundary. Correlation of external currents is obtained and spectral density of electric field correlation is calculated. (auth)

11157 ABSORPTION OF EXTRAORDINARY WAVES IN WEAKLY INHOMOGENEOUS PLASMA IN REGION OF HYBRID RESONANCE WITH OBLIQUE INCIDENCE. Omel'chenko, A. Ya. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 6, 970-4(Jun 1972). (In Russian).

Behavior of an extraordinary electromagnetic wave is considered

in the resonance region of inhomogeneous plasma, where the wave frequency becomes equal to the hybrid resonance frequency, with an oblique incidence of the wave on semi-infinite plasma. The wave absorption coefficient is determined in a case of a weak magnetic field and small incidence angles when the distance between the hybrid resonance point and point of rotation is considerably less than the wave length. The field behavior in the resonance region is determined, considering spatial dispersion when the collision frequency is small, and the formation of plasma waves should be taken into account. (auth)

11158 BOUNDARY CONDITIONS FOR PENETRATION OF AN ELECTROMAGNETIC WAVE INTO A PLASMA. Rezvov, A. V. (Gorky Physical-Technical Research Inst., USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 894-900 (Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1120-9(Jun 1972).

A kinetic-theory procedure is considered for finding the field structure inside a plasma for penetration of electromagnetic waves and in the theory of surface oscillations. The spatial dependence of the field makes it possible to isolate the region of frequencies and distances from the surface in which the discrete part of the characteristic spectrum predominates. Additional boundary conditions are formulated for this region and make it possible to calculate phenomenologically the exact values of the amplitudes of the corresponding longitudinal wave and transverse wave taking account of both the thermal motion of the particles and the mechanism by which they interact with the plasma surface. The calculations are performed for specular reflection and diffuse reflection. (auth)

11159 DAMPING OF OSCILLATIONS IN THE PLASMA–BEAM SYSTEM MODULATION BY LOW-FREQUENCY SIGNAL. Levitskii, S. M.; Shapoval, V. Z. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 796-802(May 1972). (In Russian).

It is shown experimentally that velocity modulation of the electron beam by a monochromatic signal with a frequency of 10 to 20 MHz results in a one–two order decrease in integral power of oscillations existing in the system within a frequency range of 10^5 to 10^{10} Hz. In this case, energetic losses of the beam decrease, and it passes through the plasma almost nonscattered. Dependence of oscillation damping on the beam and plasma regime, amplitude, and frequency of the modulation signal, and gas is studied. A suppositional explanation is advanced that the damping effect takes place because the parameters of the system suffer perturbation with a period commeasurable with the characteristic time of natural oscillations in the system. In this case, the conditions of rise in oscillations are disturbed and their level decreases. (auth)

11160 EXTERNAL HIGH-FREQUENCY MODULATION OF ELECTRON BEAMS AND ABSORPTION OF BEAM INSTABILITY OSCILLATIONS IN PLASMA PLACED INTO THE MAGNETIC FIELD OF MIRROR CONFIGURATION. Kovpik, O. F.; Kornilov, E. A.; Kolyada, Yu. E. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 830-3(May 1972). (In Russian).

The oscillations excited by a modulated electron beam in a mirror machine were studied. It is shown that nonlinear effects play the essential role for exciting the oscillations, especially when modulating the beam by high frequencies. The oscillations are absorbed in the inhomogeneous magnetic field at the expense of electron-cyclotron absorption. The experiments were carried out with the beam of 20 A, the energy 5 to 25 keV, and the magnetic field 3 to 1 to 3 kG. The plasma density was 10^{11} to 10^{12} cm^{-3}. The beam was modulated by a frequency of 2800 MHz. (auth)

11161 MEASUREMENTS OF THE STRUCTURE OF AN IONIZING SHOCK WAVE IN A HYDROGEN–HELIUM MIXTURE. Leibowitz, L. P. (Jet Propulsion Lab., Pasadena, CA). Phys. Fluids; 16: No. 1, 59-68(Jan 1973).

Shock structure during ionization of a hydrogen–helium mixture was followed using hydrogen line and continuum emission measurements. A reaction scheme is proposed which includes hydrogen dissociation and a two-step excitation–ionization mechanism for hydrogen ionization by atom–atom and atom–electron collisions. Agreement was achieved between numerical calculations and measurements of emission intensity as a function of time for shock velocities from 13 to 20 km/sec in a 0.208 H_2–0.792 He mixture. The electron temperature was found to be significantly different from the heavy particle temperature during much of the ionization process. Similar time histories for H_β and continuum emission indicate upper level populations of hydrogen in equilibrium with the electron concentration during the relaxation process. The expression for the rate constant for excitation of hydrogen by atom–atom collisions that best fit the data was $k_{AA} = 4.0 \times 10^{-17} (8kT/\pi\mu)^{1/2} \exp(-10/kT)$ cm^3 sec^{-1}, where it was assumed that the excitation cross section is the same for hydrogen and helium collision partners. The electron–atom excitation rate constant, $k_3 = 7.5 \times 10^{-16} (8kT_e/\pi\mu_e)^{1/2} \exp(-10/kT_e)$ cm^3 sec^{-1}, determined from this investigation, was in agreement with recent electron beam cross-section measurements. (auth)

11162 WAVES IN A HOT UNIAXIAL PLASMA EXCITED BY A CURRENT SOURCE. Singh, N.; Gould, R. W. (California Inst. of Tech., Pasadena). Phys. Fluids; 16: No. 1, 75-81(Jan 1973).

The fields excited by a short dipole antenna in a hot uniaxially anisotropic plasma ($B_0 \to \infty$) were studied. When $\omega < \omega_p$, the dipole effectively excites two propagating waves, a slow wave and a fast wave, inside a cone of half-cone angle $\sin^{-1}(\omega/\omega_p)$. Inside the cone a characteristic interference structure in the angular distribution of the fields is noted. Outside the cone fields fall off exponentially. The appearance of the cone and the characteristic interference structure in the field is useful from the viewpoint of laboratory diagnostics. (auth)

11163 MEASUREMENT OF THE ATTENUATION OF AN ELECTROMAGNETIC WAVE IN A BOUNDED HOT ELECTRON PLASMA. Blevin, H. A. (Flinders Univ., Bedford Park, Australia); Reynolds, J. A.; Thonemann, P. C. Phys. Fluids; 16: No. 1, 82-9(Jan 1973).

Under certain conditions of electron temperature and mean free path, the attenuation of an electromagnetic wave incident on a vacuum–plasma boundary cannot be described in terms of the usual complex conductivity. In a cylindrical plasma, with an electron density layer between 10^{10} and 10^{12} cm^{-3} and an electron temperature of 2.2 eV, measurements of the attenuation of a small-amplitude wave show resonance phenomena due to interaction between the wave and the moving electrons. A theory of this resonance for the case of a plasma slab is compared to the experimental results. (auth)

11164 STOCHASTIC KINETIC THEORY OF STRONG WAVE-PLASMA INTERACTION. I. KINETIC EQUATIONS. Di Bona, G.; Masselot, C. (Centre D'Etudes de Limeil, Villeneuve-Saint-Georges, France). Nuovo Cim.; 12B: No. 2, 256-68(11 Dec 1972).

The interaction of an electron plasma with a strong high-frequency electromagnetic field is studied by means of the Stratonovich stochastic method. A hierarchy of equations is carried out. An expansion in powers of a small dimensionless parameter is used to break this hierarchy. A set of two kinetic equations governing the system is obtained. (auth)

11165 WAVE CONVERSION AND ABSORPTION AT THE UPPER HYBRID RESONANCE. Budnikov, V. N.; Novik, K. M.; Fedorov, V. I. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 7, 1108-15 (Jan 1973).

Translated from Zh. Tekh. Fiz.; 42: No. 7, 1393-1403(Jul 1972).

The high-frequency field distribution and the density and electron energy are investigated for absorption of microwave radiation by a plasma. The plasma is formed by 3-cm power. The measurements are performed at values of the parameter ω/ω_{He} in the range 1 to 4. Conditions of the experiments: argon plasma at a pressure of 1.6×10^{-2} mm Hg; electron density n_e up to 2×10^{12} cm^{-3}; electron temperature $T_e \approx 5$ to 15 eV. For $\omega^2 \gg \omega_{He}^2$ a drop of two orders of magnitude in the microwave electric field in the axial direction occurs in a distance of 2 cm. In the radial direction annular regions of strong field are observed. The field maxima at different cross sections are localized near n_u, the density corresponding to the upper hybrid resonance. Wave conversion must occur at this density under the conditions of the experiment. The electron temperature in the region of absorption microwave field has different radial distributions depending on the value of the parameter ω/ω_{He}. The location of the temperature maxima with respect to n_u corresponds to regions of propagation of plasma waves formed by conversion of the electromagnetic wave near n_u. The dependence of the efficiency of absorption near electron cyclotron resonance ($\omega/\omega_{He} = 1.00, 1.14$) on density is experimentally established: The efficiency drops sharply when the electron density becomes greater than the critical value. (auth)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 9635, 10346, 10388, and 10522.

11166 (AD-868927) COMPUTERIZED ANATOMICAL MODEL MAN. Technical Report, February 7-October 7, 1969. Kase, P. G. (Martin Marietta Corp., Denver, Colo.). Jan 1970. Contract F29601-69-C-0052. 164p. (MCR-69-409; AFWL-69-161). NTIS.

The Computerized Anatomical Model Man is a detailed representation of the radiation transport properties of the human body. It is to be used for computation of the areal density distribution at specified locations in the body. This information is applicable to dose calculations in natural, weapon, reactor, and other radiation environments. The model has two configurations—standing and seated. Over 2200 individual geometrical shapes have been used to depict the external conformation, the skeleton, and the principal organs. The exterior dimensions are those of the 50th-percentile Air Force man; the skeleton and organs were scaled from life-size models to conform to the exterior. The model includes variations of material density and fractional composition by weight due to the principal chemical elements contained in muscle, bone, bone marrow, and organ tissue. The model is compatible with the North American Rockwell Modified Elemental Volume Dose Program. This has been demonstrated by solution of sample problems employing both configurations of the model with the North American Rockwell Program on the CDC 6600 digital computer at the Air Force Weapons Laboratory. (auth)

11167 (ORNL-TM-3918) TIME-DEPENDENT VACUUM ULTRAVIOLET EMISSION OF HELIUM. Bartell, D. M.; Hurst, G. S.; Wagner, E. B. (Oak Ridge National Lab., Tenn.). Sep 1972. Contract W-7405-eng-26. 108p. Dep. NTIS.

Thesis. Submitted by D. M. Bartell to Univ. of Kentucky, Lexington.

These time-dependent studies of the vuv emission from proton-excited helium gas show that the 2^1P state is depleted primarily by collisional process and that the vuv continuum has two components, both of which are pressure-dependent. The theoretical estimations illustrate in detail the initial actions when a proton interacts with helium. Molecular helium's potential curves were used extensively in constructing the suggested model. These studies are productive because they can be coupled directly with W-value experiments and other emission measurements to yield information on the energy pathways involved in the vuv continuum and in the Jesse effect. (auth)

11168 (SC-RR-720684) DINT: A COMPUTER PROGRAM WHICH PREPARES MULTIGROUP COHERENT-INCOHERENT CROSS SECTIONS FOR PHOTON TRANSPORT CALCULATIONS. Adams, K. G.; Biggs, F.; Renken, J. H. (Sandia Labs., Albuquerque, N. Mex.). Dec 1972. 65p. Dep. NTIS.

The DINT computer program prepares multigroup cross-section tables which are based upon the physics of coherent–incoherent photon scattering. One noteworthy feature of this calculational capability is the library of raw cross-section data which is an integral part of the code package. This library contains state-of-the-art cross-section information for the coherent and incoherent scattering, pair production, and photoelectric mechanisms, respectively. When used with any of the well-known discrete ordinates transport codes, the cross-section tables produced by DINT include in the transport calculation all the important photon–matter interaction processes. (auth)

11169 (SC-RR-720685) ANALYTICAL APPROXIMATIONS FOR TOTAL AND ENERGY ABSORPTION CROSS SECTIONS FOR PHOTON-ATOM SCATTERING. Biggs, F.; Lighthill, R. (Sandia Labs., Albuquerque, N. Mex.). Dec 1972. 134p. Dep. NTIS.

Analytical approximations convenient for computer use are described for total (angle-integrated) coherent and incoherent photon–atom scattering cross sections. The cross section for absorption of energy by the scattering atom is also included. The effects of electron binding were taken into account. These approximations have the property that the same simple analytical form is preserved in cases where an average effective cross section is constructed for a composite material consisting of several elements. The elements of atomic numbers $1 \leq Z \leq 100$ are included in the approximation scheme. (auth)

11170 OSCILLATORY DEPENDENCE ON THE ATOMIC NUMBER OF THE PROJECTILE ATOM FOR THE STOPPING POWER DUE TO INELASTIC COLLISIONS. Kessel'man, V. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 6, 923-7(Dec 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 6, 1161-6(Jun 1972).

Recent systematic experimental investigations have shown that the dependence of the stopping power of matter S_e on Z_1 for inelastic collisions of low-energy charged particles ($v \gtrsim v_0 Z_1^{2/3}$, where v_0 is the electron velocity in a hydrogen atom, which is equal to 2.2×10^8 cm/sec, and Z_1 is the atomic number of projectile atoms) is not monotonic (as predicted by the well-known theories of Firsov and Lindhard and collaborators), but oscillatory. This oscillatory effect is explained by taking account of the shielding of the nucleus of a projectile atom by its electrons. Analytical relationships for calculating S_e with an allowance for the oscillatory dependence $S_e(Z_1)$ for channelized and nonchannelized charged particles are derived. (auth)

11171 CHARACTERISTIC ENERGY-LOSS SPECTRA OF ELECTRONS REFLECTED FROM La, Ce, Pr, AND Nd SURFACES. Zashkvara, V. V.; Tsveiman, E. V.; Korsunskii, M. I.; Red'kin, V. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1564-6(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1812-14(Jun 1972).

Characteristic energy-loss spectra were measured for 300-eV electrons reflected from La, Ce, Pr, and Nd which were heated in vacuum to remove most oxides. The spectra were recorded at 850°C in the reflected-energy range 0 to 50 eV. The strongest peaks at 8 to 9 eV are attributed to excited bulk plasma oscillations, being in good agreement with calculated $\hbar\omega_p$ values. The peaks at 3 to 4 eV are due to surface plasma oscillations at the metal/oxide interface, as they shift toward lower energies with oxidation. The 5.3-eV peak of La is attributed to excitation of surface plasma oscillations. In the spectra above 15 eV, there are two peaks who are in good agreement with the $O_{II,III}$ and O_I ionization potentials. The interpretation of the 20.2- and 22.1-eV peaks of La is difficult. (D.L.C.)

11172 DETERMINATION OF THE AVERAGE ENERGY W, EXPENDED IN AIR PER ION PAIR FORMED FOR 60 MeV TO 120 MeV BREMSSTRAHLUNG. Hohlfeld, K.; Engelke, B. A. (Physikalisch-Technische Bundesanstalt, Brunswick). Biophysik; 9: No. 1, 85-92(1972). (In German).

By calorimetric measurement of the absorbed dose in graphite and the measurement of ionization per unit mass of air under the same conditions the average energy W_L required to produce an ion pair in air was determined for bremsstrahlung with maximum energies of 60, 90, and 120 MeV. The value of $W_L = 34.0$ eV for 60- and 90-MeV as well as 33.9 eV for 120-MeV bremsstrahlung agrees with the well-known value of $W_L = 33.73$ eV as given by the ICRU for energies below 2 MeV. (auth)

11173 DEPTH DOSE DETERMINATION. 1. TISSUE-EQUIVALENT LIQUIDS FOR STANDARD MAN AND MUSCLE. Frigerio, N. A.; Coley, R. F.; Sampson, M. J. (Argonne National Lab., IL). Phys. Med. Biol.; 17: No. 6, 792-802(Nov 1972).

Requirements for tissue-equivalent mixtures are discussed, and methods described for formulating mixtures exact in elemental composition and density. Methods are also given for estimating the densities and vapour pressures of mixtures of known compounds, as well as a list of the properties of compounds useful in tissue-equivalent formulations. A density value of 1.066 ± 0.003 g cm^{-3} at 37°C is obtained for lean mammalian muscle, from the literature and from experiments. A density of 1.063 g cm^{-3} at 37°C is obtained from the literature, for Standard Man exclusive of air voids. Tissue-equivalent liquids and their properties are presented for Standard Man and for lean muscle. These are exact in composition for C, H, O, N, Ca, P, S, K, Na, Cl and Mg, range from 1.012 to 1.016 g cm^{-3} in density at 25°C, and include mixtures for the standard density range of 1.06–1.07 g cm^{-3}. Two simplified mixtures are also described, correct only for C, H, O and N, for use where exact elemental composition is not important. (auth)

11174 SOLID GEOMETRY VERSUS PLANE GEOMETRY FOR ^{252}Cf SOURCES. Jones, T. D. (Oak Ridge National Lab., TN). Phys. Med. Biol.; 17: No. 6, 858-9(Nov 1972).

A brief correction is made to a previous paper (Krishnaswamy, Phys. Med. Biol., 17: 56(1972)). Errors are pointed out in the 2-, rather than 3-dimensional calculation of depth dose tables for ^{252}Cf sources in tissue with particular reference to radiotherapy where neoplasms show biological changes due to a 10% variation in radiation dose. (UK)

11175 SOLID GEOMETRY VERSUS PLANE GEOMETRY FOR ^{252}Cf SOURCES. Krishnaswamy, V. (Albert Einstein Coll. of

Medicine, Bronx, NY). Phys. Med. Biol.; 17: No. 6, 860(Nov 1972).

Brief reply is made to criticisms of a previous paper (Krishnaswamy, Phys. Med. Biol., 17: 56(1972)). Errors are discussed arising from the calculation of depth dose tables for ^{252}Cf radiotherapy implants with particular reference to the use of planor rather than solid geometry. It is stated that calculations were within 3% of experimental results. (UK)

11176 COMPUTER EVALUATION OF SIEVERT'S INTEGRAL BY RECURSIVE FORMULA. Worthley, B. W.; Nicholls, R. L. (Univ. of Adelaide). Phys. Med. Biol.; 17: No. 6, 854-7(Nov 1972).

Sievert's integrals are involved in the calculation of dosage at points in the vicinity of screened linear sources of γ radiation. The integral may be written as the summation of a convergent series, and the same is true for the integral that occurs when tissue attenuation factors are included. The latter series can be expressed in an iterative form which lends itself to computer evaluation, and as a special case, to the evaluation of Sievert's integral. The accuracy and speed of this method were compared with those obtained using Simpson's method and tabulated values of Sievert's integral. Although a three-ordinate Simpson's rule was sufficient to give a worst possible error of <0.2%, it was found that the iterative method was at least three times faster. A subroutine written in Fortran IV is available for five different isotopes, including ^{137}Cs. (UK)

11177 METHOD FOR THE DETERMINATION OF THE DIFFERENTIAL ALBEDO FOR PHOTONS WITHIN THE ENERGY RANGE FROM 2 TO 17 MeV. Vogt, H. G. (Technische Univ., Hanover). Nucl. Eng. Des.; 22: No. 1, 138-60(1972). (In German).

An experimental method has been proved for the determination of the differential albedo for photons within the energy range from 2 to 17 MeV. The arrangement consists of a betatron as the source, the material specimen, and a sodium iodide crystal joined to a multi-channel analyzer as the detector unit. A narrow collimated beam strikes the shielding slab, built on a turning stage. The backscattered radiation can be measured at several scattering angles of the arrangement by moving the detector on a carriage around the shield model. The unscattered radiation is measured separately with the shield outside of the primary beam. Each measurement of the backscattered radiation and of the primary radiation give together the differential albedo for the respective polar and azimuthal angles of the primary and of the scattered beam. The albedos are related to the spectrum of the betatron bremsstrahlung. In order to obtain albedos for monoenergetic radiation the betatron energy has to be varied within the energy range of interest. A system of linear equations which follow from the measurements at different maximal energies of the bremsstrahlung gives the final results. The measured pulse spectra are unfolded to energy spectra by means of response matrices, obtained from measurements and special analytical calculations. The evaluation of the numerous data for the determination of energy spectra and exposure rates as well as the calculation of albedos for monoenergetic radiation from those for energy spectra is done in computer codes which make the calculational efforts reasonable. Measurements have been performed with an aluminum slab. The resulting differential exposure albedos and double differential number albedos (current albedos for a semi-infinite medium) are partly in good agreement with theoretical calculations. (69 references) (auth)

11178 IMPROVED MOMENT METHOD CALCULATIONS OF GAMMA-RAY TRANSPORT: APPLICATION TO POINT ISOTROPIC SOURCES IN WATER. Spencer, L. V.; Simmons, G. L. (National Bureau of Standards, Washington, DC). Nucl. Sci. Eng.; 50: No. 1, 20-31(Jan 1973).

Estimated error bounds derived from polynomial calculations have been used to revise the truncation error estimates of published data on gamma-ray penetration in water. It is also shown that more efficient use of moment data is possible to obtain greater accuracy in specific penetration regions and to extend the accuracy of polynomial calculations to greater penetrations. The results also indicate that in addition to the asymptotic power law, data to perhaps 40 mean-free-paths may be needed to make accurate extrapolations to arbitrarily great penetrations. (auth)

11179 MOMENTS METHOD CALCULATION OF BUILDUP FACTORS FOR POINT ISOTROPIC MONOENERGETIC GAMMA-RAY SOURCES AT DEPTHS GREATER THAN 20 MEAN FREE PATHS. Morris, E. E. (Univ. of Notre Dame, IN). Nucl. Sci. Eng.; 50: No. 1, 32-7(Jan 1973).

A method of extending moments method calculations for monoenergetic, point isotropic gamma ray sources to depths of approximately 50 mean free paths is described. Sample calculations are given for water and aluminum. A method of error analysis recently developed by Spencer suggests that, for the range from 10 to ~50 mean free paths, the errors associated with the reconstruction of the flux from moments are generally <1%. Comparisons are made between the asymptotic, deep penetration trend of the calculated results and the trend predicted by a theory developed by Fano. (auth)

11180 MEASUREMENT OF THE VOLTAGE OF DIAGNOSTIC X-RAY TUBES USING K-CHARACTERISTIC FLUORESCENCE. Davison, M.; Law, J. (Western Regional Hospital Board, Glasgow). Phys. Med. Biol.; 17: No. 4, 572-6(Jul 1972).

The onset of K-characteristic fluorescence was used to measure the voltage of diagnostic x-ray tubes. A summarized comparison is presented of the following methods: (1) the use of a single detector (scintillation counter) to measure the intensity of side-scattered radiation from the selected element; and (2) the use of two detectors to measure both side-scattered and transmitted radiation intensities, a graph being made of their ratio. "Adrian" type ionization chambers were used, the 35-cm^3 size to measure the transmitted x rays and the 350-cm^3 size for the scattered x-ray intensities. Results (agreeing to within 1 kV) are presented for both methods, using Ta, Au, and Pb as scatterers and differential absorbers. The relative merits of the methods are discussed and data are presented showing the influence of beam width on the ratio method for a self-rectified unit. (UK)

11181 COMPARISONS OF 10 TO 40 MeV ELECTRON AND X-RADIATION DOSIMETRY METHODS. Svensson, E. O. (Umeaa Univ., Sweden); Svensson, H.; Hettinger, G.; (and others). Phys. Med. Biol.; 17: No. 6, 783-91(Nov 1972).

Comparisons have been made between the dosimetry methods for 10- to 40-MeV electrons and x radiation used at the radiation treatment centers in Essen (Germany) and Villejuif (France) by the respective resident staff and that used by a visiting group from the center in Umeå (Sweden). The absorbed doses from both electron and x radiation and the relative electron depth doses were measured using thimble ionization chambers. Electron isodose curves were derived from data obtained with photographic films. In both comparisons, Essen-Umeå and Villejuif-Umeå, the absorbed dose and relative electron depth dose data showed good agreement while the electron isodose curves showed significant discrepancies. (auth)

11182 PHOTON INTERACTION PROCESSES: THEIR RELATIVE IMPORTANCE IN BONE AND MUSCLE. Buchan, R. C. T. (Plymouth General Hospital, Eng.). Radiography; 38: No. 456, 319-22(Dec 1972).

Recently published data have been used to derive graphs showing the relative importance of the various photon interaction processes in muscle and bone throughout the photon energy range employed in radiodiagnosis and radiotherapy. The relative importance of a particular interaction process is expressed as the percentage of the mass attenuation coefficient for all the processes operating. Compton and coherent scattering, pair production and photoelectric processes are considered. (auth)

Radiation Protection Standards

Refer also to abstract 11188.

Shielding Calculations and Experiments

Refer also to abstract 11177.

11183 (ORNL-RSIC-35) SHIELDING OF MANNED SPACE VEHICLES AGAINST PROTONS AND ALPHA PARTICLES. Alsmiller, R. G. Jr.; Santoro, R. T.; Barish, J.; Claiborne, H. C. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 525p. Dep. NTIS.

The available information on the shielding of manned space vehicles against protons and alpha particles is summarized. The emphasis is on shielding against Van Allen-belt protons and against solar-flare protons and alpha particles, but information on shielding against galactic cosmic rays is also presented. The report is primarily intended as a handbook for nonexperts in space shielding. For the most part, the approximation methods discussed are those that are standard in the space-shielding literature. A large amount of numerical data, not previously published, on the validity of the various approximation methods is presented. (auth)

11184 (RT/FI-(72)29) MULTIGROUP TREATMENT OF THE THIRD FORM OF THE BOLTZMANN EQUATION WITH ANISO-

TROPIC SCATTERING IN MULTILAYER SHIELDS. Premuda, F. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy). Centro di Calcolo). 12 Jul 1972. 38p. Dep. NTIS (U. S. Sales Only).

Within the framework of a multigroup transport theory the neutron total and angular fluxes due to different monoenergetic monodirectional sources, have, in the presence of scattering and fission with arbitrary anisotropy order L, been determined for each energy group in a multilayer shield. From the I-group formulation of the third form of the Boltzmann equation the system of Ix(L + 1) integral equations for the first (L + 1) moments of the angular fluxes in all the I energy groups were derived. Through the "exponential transformation" slowly variable modified moments have become the unknowns of a modified integral system of the Fredholm kind. Its series solution in each group was obtained through series expansions, layer by layer, of the kernels. Iterative techniques for evaluation of the coefficients of the series solution were widely discussed from a physical point of view. Finally, from two different analytical expressions of the moments a return was made, in two different ways, to four alternative forms of the exact series solution of the original multigroup Boltzmann equation for the angular fluxes. (auth)

PHYSICS (SOLID-STATE)

11185 SEMICONDUCTORS: PREPARATION, CRYSTAL GROWTH, AND SELECTED PROPERTIES. Connolly, T. F. (ed.). Solid State Physics Literature Guides. Volume 2. New York; Plenum Publishing Corporation (1972). 229p. $14.50.

This bibliography of ~6,000 references is arranged according to the chemical groups of the compounds. Special sections are included on amorphous semiconductors and ion implantation, as well as organic semiconductors. Information centers and other services are listed. (D.L.C.)

Radiation Effects

11186 (AD-744516) PARAMAGNETIC RESONANCE STUDIES OF Y_2O_3, CeO_2, AND ThO_2. Wagner, G. R.; Murphy, Joseph; Feldman, Donald (Westinghouse Research Labs., Pittsburgh, Pa.). Feb 1971. Contract F33615-68-C-1681. 81p. (ARL-72-26). NTIS.

Electron spin resonance investigations of paramagnetic point defects in single crystals of Y_2O_3, CeO_2 and ThO_2 are reported. Centers present in the as-grown crystals as well as those induced by low-temperature uv irradiation were studied. In some cases bleaching of uv-induced centers was correlated with thermoluminescence peaks of the same sample. Models for some of the uv-induced centers are proposed, and theoretical calculations of the g-values were carried out. (auth)

11187 (CEA-CONF-2064) ELECTRICAL RESISTIVITY, STORED ENERGY, INTERNAL FRICTION AND MAGNETIC AFTEREFFECT. Moser, P. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 28p. (In French). (CONF-720570-1). Dep. NTIS (U. S. Sales Only).

From Conference of the French Society of Electron Microscopy; Nantes, France (29 May 1972).

The preliminary migratory mechanisms and the agglomeration processes associated with defects created in materials (Fe) by irradiation were studied by observing the increased resistivity produced and the changes in the stored energy, internal friction, and magnetic aftereffect. The recovery in the electrical resistivity of pure Fe and Fe containing 0.004 and 0.015 wt % C which had been subjected to electron bombardment was studied during isochronal annealing. The results are represented graphically. The defects produced in a metal by neutron bombardment were also studied by resistivity changes. A device for measuring the energy released when the temperature is increased linearly is presented. The resistance recovery and the simultaneous release of stored energy in irradiated iron was studied. Internal friction measurements were used to investigate the disturbance produced in the structure by the presence of interstitials. The internal friction pendulum diagram and the peaks which appeared after neutron irradiation are given for Fe. The diagram corresponding to a magnetic aftereffect experiment is presented; the magnetic aftereffect bands appearing in electron-irradiated Fe are presented. The 90° rotation produced in the Bloch wall by an external magnetic field and the stabilization of a wall at 90° are discussed. (France)

11188 (CONF-721037-1) PROPOSED STANDARD FOR CALCULATING DISPLACEMENT DOSE RATES. Norgett, M. J.; Robinson, M. T.; Torrens, I. M. (Oak Ridge National Lab., Tenn.). Aug 1972. 14p. Dep. NTIS.

From Specialists' meeting on radiation damage units for ferritic and austenitic stainless steels; Seattle, WA. (31 Oct 1972).

A simple procedure is proposed for calculating the number of atomic displacements produced in a damage cascade by a primary knock-on atom of known energy. The formulas are chosen to give results in close accord with recent computer simulations of radiation-damage phenomena. The proposed new standard is compared with other empirical formulas for estimating the number of atomic displacements in a cascade. (auth)

11189 (COO-3171-9) DEFECT CLUSTERS IN ELECTRON IRRADIATED ALUMINUM FILMS. PART I. ON THE NATURE OF DISLOCATION LOOPS. Rao, P. (Cornell Univ., Ithaca, N. Y.). Aug 1972. Contract AT(11-1)-3171. 60p. Dep. NTIS.

It is shown that the nature of dislocation loops resulting from the clustering of point defects in electron-irradiated aluminum can be satisfactorily determined if intuition is used to obtain self-consistent results. This involves an ability to make a clear distinction between "in-contrast" and "residual" images, imaging with $\pm g$ such that $g \cdot b \geq 2$ and ξ_g is large, and being able to determine the sense of rotation of the major axis of the loop which uniquely reflects changes in n during a systematic tilting experiment. The Burgers vector of all loops analyzed are of the a/2 ⟨110⟩ type as expected in fcc crystals. Loop plane normals have been observed to vary from exact ⟨111⟩ to exact ⟨120⟩ to between ⟨120⟩ and ⟨110⟩ orientations. Actually, loop plane normals have been observed to be within 10° of ⟨111⟩ and to within 17° of ⟨120⟩. Of all the loops analyzed, 41% are interstitial in nature, 30% are vacancy in nature, and 29% are indeterminate. Expressed otherwise, 63.5% of the point defects condensing into dislocation loops contribute to interstitial loop formation, 21.6% contribute to vacancy loop formation while 14.9% are involved in loops whose nature cannot be conclusively assessed. Loops analyzed to be interstitial in nature vary in diameter from 200 Å to 2800 Å, vacancy loops vary in diameter from 200 Å to 800 Å, while loops of indeterminable character vary in diameter from 200 Å to 1100 Å. Loop plane normals have been found to be dependent on loop size. Loops in the size range 200 to 850 Å lie on {111} loop planes, loops in the size range 850 Å to 1500 Å lie on {012} planes (primarily "diamond" shaped), while loops larger than 1500 Å diameter lie on loop planes close to but between the {012} and {110} planes. (TSS)

11190 (COO-3171-10) OBSERVATION OF DAMAGE IN HELIUM ION IRRADIATED GOLD FILMS USING TRANSMISSION ELECTRON MICROSCOPY. Brown, R. D.; Rao, P.; Ho, P. S. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). 10 Nov 1972. 22p. Dep. NTIS.

Transmission electron microscopy was applied to the study of damage in gold irradiated with 35-keV He^+ ions to fluences of 10^{14} to 10^{16} ions/cm^2. Damage in as-irradiated specimens consisted of dislocation loops showing double arc contrast that loop analysis revealed to be about 30 to 50% interstitial in nature. Depth distributions of the defect clusters were determined using stereo microscopy. Annealing at increasing temperature resulted in a decrease in loop density together with an increase in loop diameter. Voids formed at annealing temperatures between 0.5 and 0.58 T_m on and in the vicinity of dislocation tangles formed from the loops, and were identified from a through-focus sequence of micrographs and by kinematical imaging. Increasing void diameter with decreasing void density on annealing at higher temperature indicated that the voids were gas-filled and were growing via migration and coalescence. (auth)

11191 (SRARI-P-125) INVESTIGATION OF THE CONDUCTIVITY OF PORCELAIN DURING AND AFTER IRRADIATION IN A HIGH-FLUX REACTOR. Aseev, N. A.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 23p. (In Russian). Dep. NTIS (U. S. Sales Only).

Results on conductivity changes in various compositions of porcelain during and after irradiation in SM-2 reactor channels are given. It is shown that the conductivities of inorganic and ceramic dielectrics under irradiation have several components (temperature, ionic, and dose) with corresponding activation energies of carriers. (auth)

11192 (SRARI-P-129) METHODS FOR IN-PILE INVESTIGATIONS OF THE ELECTRIC AND THERMAL CONDUCTIVITIES IN DIELECTRICS. Aseev, N. A.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 34p. (In Russian). Dep. NTIS (U. S. Sales Only).

Results on the development and application of devices for the direct measurement of changes in electric and thermal conductivities of dielectric materials during irradiation in a high-flux reactor are given. Analysis of possible errors in weak current measurements under the conditions of heavily ionized media and high activation of applied materials is performed. Some recommendations for applying the specific measuring schemes are given. (auth)

11193 OBSERVATION OF COLOR DISTRIBUTION IN ALKALI METAL HALIDE CRYSTALS SUBJECTED TO ION BOMBARDMENT. Krokhina, A. I.; Antoshin, M. K.; Spivak, G. V. Izv. Akad. Nauk SSSR, Sr. Fiz.; 36: No. 9, 1915-16(Sep 1972). (In Russian).

A scanning electron microscope with cathode luminescence was used in observing colors in the ionic crystals NaCl, KCl, KBr, and LiF resulting from ion bombardment. The ionic crystals were heated to 300 to 400°C, whereupon they acquired sufficient conductivity to function as a cathode in a discharge. The discharge occurred at 10^{-2} torr, a voltage of 1 to 5 kV, and 1 to 5 mA of current. The geometry of the samples was then depicted

as an image by scanning electron microscopy in a secondary emission regime. Colors generated by ion bombardment remained stable for at least 10 years. (K.S.W.)

11194 RELAXATION OF THE ELECTRON EMISSION FROM GERMANIUM BOMBARDED WITH N_2^+ AND Kr^+ IONS. Omel'yanovskaya, N. M.; Lebedev, S. Ya. Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1542-3(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1792-3(Jun 1972).

The time dependence of the electron emission coefficient γ_e was studied for the (111) face of a Ge single crystal during bombardment by 68-keV N_2^+ or 32-keV Kr^+ ions. Irradiation of a sample at an angle φ_1 for a time sufficient to reach steady state, was followed by a change in the incident angle to ϕ_2 and further measurements. Below the defect-annealing temperature (>300°C), $\gamma_e(t)$ was identical for all φ changes, with only a very small fall in γ_e during the first few moments. At 360 or 380°C, $\gamma_e(t)$ was different for φ changes, as was observed earlier for 70-keV Ar^+ ions. The relaxation curves were used to derive two characteristic times, τ_1 for the maximum or minimum and τ_2 for the total relaxation time. τ_1 for a change from 58° to 0° on the (111) face was determined to be 18, 10, and 5 sec for N_2^+, Ar^+, and Kr^+ ions, and the corresponding diffusion coefficients of the displaced atoms were calculated to be 4.5×10^{-12}, 4.2×10^{-12}, and 10^{-12} cm^2 sec. τ_2 was 200, 70, and 70 sec, respectively. (D.L.C.)

11195 HYDROGEN-BONDED FERROELECTRICS: EVIDENCE FOR SLATER CONFIGURATIONS FROM E.P.R. STUDIES OF X-IRRADIATED KH_2AsO_4 AND $NH_4H_2AsO_4$. Dalal, N. S.; McDowell, C. A.; Srinivasan, R. (Univ. of British Columbia, Vancouver). Mol. Phys.; 24: No. 5, 1051-7(Nov 1972).

The temperature dependence of the powder EPR spectrum of the AsO_4^{4-} center in x-irradiated samples of KH_2AsO_4 and $NH_4H_2AsO_4$ yields results which can be understood as arising from exchange processes taking place between the six configurations in the Slater model for this type of hydrogen-bonded ferroelectric and antiferroelectric. Knowing that the ^{75}As hyperfine parameters have rhombic symmetry in the compounds studied, it is possible to interpret certain specific features in the spectra as being associated with the Slater configurations of higher energy. (auth)

11196 FORMATION OF F CENTERS IN OXYGEN-DOPED NaCl CRYSTALS. Didyk, R. I.; Tsal, N. A. (Lvov State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1596-8(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1840-3(Jun 1972).

The accumulation of F centers upon x irradiation was studied using $NaCl : O^{2-}$, pure NaCl, $NaCl : NaOh$, and $NaCl : CaCl_2$ crystals. The temperature dependences of the formation rates of the F centers were measured during the first accumulation stage. The most sensitive crystals were $NaCl : O^{2-}$, followed by $NaCl : CaCl_2$ (steeper slope), $NaCl : OH^-$, and pure NaCl. The F-center formation in $NaCl : O^{2-}$ was most efficient at 300 to 320°K. When $NaCl : O^{2-}$ was irradiated at 85°K and then heated to room temperature, the number of F centers increased considerably, along with thermoluminescence. Results can be explained: Irradiation ionizes the Cl^- and O^{2-} ions. $O^{2-} \rightarrow O^- + e$ + vacancy $\rightarrow O^- + F$. Raising the temperature also induces the reaction $2O^- \rightarrow O_2^-$ + vacancy + e $e \rightarrow O_2^- + F$. (D.L.C.)

11197 ION IMPLANTATION INTO INSULATORS: CHARGE-REMOVAL STUDIES USING ION-INDUCED CHARACTERISTIC X RAYS. Beezhold, Wendland; EerNisse, E. P. (Sandia Labs., Albuquerque, NM). Appl. Phys. Lett.; 21: No. 12, 592-5(15 Dec 1972).

The effectiveness of a number of charge-removal techniques during ion implantation into insulators was examined by monitoring the ion-induced characteristic x-ray emission of target atoms during proton implantation. Successful removal of charge buildup occurs for samples which are coated with a thin conducting surface layer and for samples which have intimate contact between the implanted region and a conducting mask and are flooded with a defocussed ion beam. (auth)

11198 FLUORINE ION IMPLANTATION PROFILES IN GALLIUM ARSENIDE AS DETERMINED BY AUGER ELECTRON SPECTROSCOPY. Harris, J. S.; Harris, J. M.; Marcus, H. L. (North American Rockwell Science Center, Thousand Oaks, CA). Appl. Phys. Lett.; 21: No. 12, 598-601(15 Dec 1972).

The distribution of fluorine ions implanted into gallium arsenide was determined through the use of Auger electron spectroscopy combined with thin-layer removal by argon ion sputtering. This technique is a chemical measure of the ion distribution and thus is not affected by the electrical properties of the implanted species. The leading edge and depth of the peak fluorine concentration are in fair agreement with the calculated Linhard, Scharff, and Schiott distribution; however, the trailing edge exhibits a tail which extends much deeper than expected. This tail is assumed to be due to damage-enhanced diffusion. (auth)

11199 INFLUENCE OF IMPLANTATION TEMPERATURE AND SURFACE PROTECTION ON TELLURIUM IMPLANTATION IN GaAs. Harris, J. S. (North American Rockwell Science Center, Thousand Oaks, CA); Eisen, F. H.; Welch, B.; (and others). Appl. Phys. Lett.; 21: No. 12, 601-3(15 Dec 1972).

GaAs samples were implanted with tellurium at room temperature or at 150°C and annealed to 750°C with an SiO_2 or Si_3N_4 protective layer. The highest electron concentrations and brightest photoluminescence were obtained for the hot implants with a Si_3N_4 protective layer. (auth)

11200 EPR INVESTIGATION OF RADIATION-INDUCED IODINE COMPLEXES IN POTASSIUM CHLORIDE AND POTASSIUM IODIDE DOPED WITH IODINE AND LEAD. Chernault, J. A. Troy, NY; Rensselaer Polytechnic Inst. (1972). 183p. University Microfilms Order No. 72-30,199.

Thesis.

The I_2^- molecule ion V center was investigated in single crystals of $KCl : I : Pb^{2+}$ and $KI : Pb^{2+}$. Gamma irradiation was conducted at 77°K. In unannealed crystals both Cl_2^- and I_2^- centers of the V_K type were observed. The relative abundance of these centers at several levels of iodine doping was consistent with the greater electron affinity of the chlorine atom and with limited hole mobility at 77°K. The characteristics of the I_2^- V_K center supported the accepted model of this type center: two equivalent ions and axis of the center aligned along a [110] crystal direction. The EPR spectra of the center were analyzed. The perpendicular component of the g-tensor was calculated to be 2.255 ± 0.006 from the $\theta = 45°$ orientation. Lines of the $\theta = 45°$ spectrum were measured and calculated. The $KCl : I : Pb^{2+}$ crystals were annealed through two procedures. During the annealing, the Cl_2^- V_K centers were observed to decay away by −60°C as thermal motion allowed migration of the center through the lattice until the hole was trapped on a more stable site. The I_2^- V_K center population increased to a peak value at −40°C and then decayed away at higher temperatures and was gone by +80°C. With the loss of the I_2^- V_K centers, a new I_2^- center appeared which was identified as a V_F-type center. This center was again analyzed through the spin Hamiltonian and the Hamiltonian parameters were calculated. The association of a positive ion vacancy with the center causes the molecular bond to bend and the bending angle was calculated to be $5.64 \pm 0.02°$. With the appearance of the I_2^- V_F center a third form of the I_2^- center was also found which produced an EPR spectrum of lower intensity than the V_F center and with a greater hyperfine coupling than the V_F center. It is aligned along a [110] crystal direction. The signal amplitude of this center was measured at several levels of iodine and the lead doping and the spectra at $\theta \neq 0°$ orientations were studied. This center displays characteristics of the V_3 optical center discussed by Seitz and appears to depend on the relative abundance of I_2^- centers and positive ion vacancies. The two iodine ions of the center appear to be equivalent. It is proposed that this new center is the I_2^- molecule ion with two associated positive ion vacancies, and it is called a V_M center. The spin Hamiltonian parameters were calculated as $g_z = 1.9318 \pm 0.0003$, $g_\perp = 2.24 \pm 0.01$, $A_z = 494.7 \pm 0.2$ G, $A_\perp = 226 \pm 2$ G, and $P = 49.1 \pm 0.5$ G. The I_2^- V_K center was found in $KI : Pb^{2+}$ and its spectrum was analyzed. Mobility of the center at 77°K produced a low-order time-dependent loss of the signal. Annealing the crystal did not produce a V_F-type center. The holes were trapped on a center involving impurity oxygen. (Diss. Abstr. Int., B)

11201 OXYGEN DISPLACEMENT ENERGY IN ZnO. Meese, J. M.; Locker, D. R. (Univ. of Dayton, Ohio). Solid State Commun.; 11: No. 11, 1547-50(1 Dec 1972).

A displacement threshold at 310 keV was observed by electrical measurements in single-crystal ZnO and was identified as the minimum electron energy required for oxygen displacements by observing the production of F^+ centers above this threshold with EPR. (auth)

11202 RAPID DETERMINATION OF SEMICONDUCTOR DOPING PROFILES IN MOS STRUCTURES. Zohta, Y. (Toshiba Research and Development Centre, Kawasaki, Japan). Solid-State Electron.; 16: No. 1, 124-6(Jan 1973).

A simple method for the rapid measurement of the doping profile of implanted ions in silicon using a nondestructive method is given. A Copeland profiler (IEEE Trans Electron Devices, ED-16: 445(1969)) and a signal generator used for applying an ac gate bias to drive the MOS capacitor into deep depletion are involved in the method. The system is based on the same principle as the pulsed capacitance–voltage method (Van Gelder and Nicollian, J. Electrochem. Soc., 118: 138(1971)) but it has the advantages of simplicity and immediate results. (UK)

11203 METHOD AND APPARATUS FOR PRODUCING THIN ELECTRICALLY INSULATING FILMS BY MEANS OF ION SPUTTERING. Fiedler, O.; Weissmantel, C.; Reisse, G. (to VEB Elektromat). British Patent 1,292,138. 11 Oct 1972. Filed 11 Nov 1969.

It is stated that, in view of the special qualities of films produced by ion sputtering, there is an increasing interest in use of this method. Disadvantages of apparatus developed so far for the process are stated, and the object of the apparatus described is to reduce or eliminate these disadvantages and, in particular, to reduce the charge on the target and adjoining areas in order to improve film quality. This positive charge is compensated by means of electron streams of required intensity and direction. Means are provided for applying an alternating rf voltage to the target, together with means for directing the ion beam on to the target. An electron beam source is arranged adjacent to the target so that, in operation, the electrons are drawn into a positive-charge region produced by the ion beam at or adjacent to the target, in order to substantially neutralize the positive charge. The intensity of the electron beams is substantially the same as that of the ion beam, and the accelerating voltage is chosen so that the electrons do not diffuse back into the ion-generating system to a significant extent and do not cause bombardment outside the region to be neutralized. The method of use of the apparatus is described. (UK)

11204 EFFECTS OF GAMMA IRRADIATION ON ACTINIDE IONS IN CALCIUM FLUORIDE. Stacy, J. J.; Edelstein, N.; McLaughlin, R. D. (Univ. of California, Berkeley). J. Chem. Phys.; 57: No. 11, 4980-8(1 Dec 1972).

Optical absorption and thermoluminescence measurements were used to study the effects of gamma irradiation on trivalent actinide ions in CaF_2. Thermoluminescent glow curves for Np, Pu, Am, and Cm (and, for comparison, the lanthanides Er, Ho, and Tm) were measured between 100 and 300°K. These were found to be remarkably similar, with glow peaks occurring at nearly the same temperatures for each of the ions. High-resolution measurements of the spectra of the thermoluminescence showed that the emission is similar to the fluorescence of the trivalent ions. Evidence is presented that the glow emission below 300°K originates from trivalent actinide ions in cubic sites. When the actinide–CaF_2 crystals were irradiated at 300°K, the actinide ion was oxidized to the tetravalent state. A mechanism is proposed to explain these observations. (auth)

11205 NEUTRON-INDUCED DAMAGE IN p- AND n-TYPE PbS SINGLE-CRYSTAL FILMS. Culpepper, R. M. College Park, MD; Univ. of Maryland (1972). 197p. University Microfilms Order No. 72-29,428.

Thesis.

The Hall coefficient, resistivity, and charge carrier mobility of epitaxial films of n- and p-type PbS having carrier concentrations between 1×10^{17} and 1×10^{18} cm^{-3} were measured in the temperature range of 4.5 and 300°K before and after successive neutron irradiation. The irradiations in the National Bureau of Standards reactor at Gaithersburg, Maryland were in four steps of approximately 3.5×10^{16} neutrons per cm^2 each. The variation of the Hall coefficient with irradiation level was used to calculate the carrier removal rate. Information about radiation-induced localized energy states in the energy band gap was obtained from change of the Hall coefficient with temperature. The variation of mobility with temperature provided information about the defect scattering mechanism. Cascade displacement theory was applied to PbS to predict the concentrations of Pb and S displacements. This information in conjunction with the carrier removal rate gave the number of removals per defect pair. The carrier concentration of both n- and p-type films was lowered at a rate of about 3.3 carriers-cm^3 per fast neutron cm^2. Also there is evidence of energy levels that are approximately 0.006 eV from the band edges, but no evidence of energy levels between 0.006 and 0.02 eV of the band edges. The results of the cascade model prediction and of the measured decrease in carrier concentration indicate that each displacement pair is responsible for at least three carrier removals. The mobility-temperature data lead to the conclusion that, while there is no change in the carrier scattering mechanism for holes with neutron irradiation, this scattering mechanism for electrons is changed by neutron irradiation. (Diss. Abstr. Int., B)

11206 IRRADIATION OF GERMANIUM WITH 1- AND 28-MeV ELECTRONS. Spitsyn, A. V.; Gasumov, G. M.; Abiev, A. K. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 142-6(1972). (In Russian).

Experimental data on the irradiation of Ge with a beam of electrons made it possible to compare results of 1-MeV electrons with 28-MeV electrons. Samples of n-type Ge were irradiated at 75°K with 1-MeV electrons and at 85°K with 28-MeV electrons, with the maximum doses that would still permit the Ge to retain its n-type conductivity. Isochronous annealing of the irradiated samples was conducted over the temperature range 110 to 372°K; a conspicuous "step" in the temperature curve occurred near 280°K. The relative Hall mobility, μ_a/μ_o, was studied as a function of the annealing temperature (μ_a and μ_o represent the Hall mobilities after and before annealing). The concentration of defects was investigated as a function of the integral electron flux. (K.S.W.)

11207 TRAPPED-HOLE CENTER DISPLAYING ORTHORHOMBIC SYMMETRY IN MgO. O'Mara, W. C.; Wertz, J. E. (Univ. of Minnesota, Minneapolis). J. Magn. Resonance; 8: No. 4, 366-75(Dec 1972).

A trapped-hole center induced in MgO by ionizing radiation is shown to be consistent with a hole trapped at a cation vacancy (V^- center) with a nearby perturbing defect that lowers its symmetry from tetragonal to orthorhombic. For brevity, it is referred to as the V_{OR} center. ESR spectra at X band (~9.5 GHz) and at K_u band (~17.5 GHz) that characterize the center are presented. Principal values of the g tensor of the V_{OR} center are: g_{XX} = 2.03960, g_{YY} = 2.03668, g_{ZZ} = 2.00328. The principal axes are slightly displaced with respect to the crystal axes, but the g components are close to the V^- center values of $g_\perp$ = 2.03859 and $g_{||}$ = 2.00327. These suggest a trapped-hole center modified by an impurity also trapped by the cation vacancy. The simplest model displaying such behavior is an OH ion at a tenth-nearest neighbor position with respect to the trapped hole; the OH bond is directed more or less toward the cation vacancy; because of its interstitial location it is incapable of lying in the (001) plane. (auth)

11208 ANISOTROPY OF HALL MOBILITY OF CURRENT CARRIERS IN γ-IRRADIATED n-Ge WITH OXYGEN IMPURITY. Baranskii, P. I.; Peller, V. V.; Shershel, V. A. (Inst. of Semiconductors, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 834-5(May 1972). (In Russian).

Changes in the Hall mobility of current carriers were investigated in n-Ge crystals with oxygen impurity (with various crystallographic orientations) under the influence of ^{60}Co gamma radiation. Not only the absolute value of the changes in Hall mobility, but also the sign of these changes depended on the state of the oxygen impurities in the samples investigated. (K.S.W.)

11209 EFFECT OF 1.2-MeV ELECTRON IRRADIATION ON ELECTROPHYSICAL PROPERTIES OF SINGLE CRYSTALS OF p-Si GROWN IN A HYDROGEN ATMOSPHERE. Levchuk, L. V.; Galushka, A. P.; Konozenko, I. D. (Inst. of Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 5, 851-4(May 1972). (In Russian).

The effects of 1.2-MeV electrons at room temperature on the Hall effect and conductivity of single crystals of p-Si were studied. The Si crystals had been grown in a H_2 atmosphere and had a specific resistance of 300 to 10^4 ohm·cm. The 1.2-MeV electron irradiation caused an increase in the concentration of current carriers at room temperature independently of the initial specific resistance of the Si. Beyond an established dose that achieved saturation, the carrier concentration decreased, as in ordinary materials. (tr-auth)

11210 HELIUM IMPLANTATION AND RE-EMISSION FROM NIOBIUM AT ELEVATED TEMPERATURES. Bauer, W.; Morse, D. (Sandia Labs., Livermore, Calif.). J. Nucl. Mater.; 44: No. 3, 337-40(Sep 1972).

One of the potential material problems associated with controlled thermonuclear reactors involves the exposure of the first wall at elevated temperatures to charged particles. In some designs it is contemplated that electrodes will directly capture charged particles emanating from the plasma. It is important that particles be re-emitted and not remain embedded in the electrodes. The results of helium re-emission as a function of input dose during 300-keV helium-ion implantation of niobium at different temperatures are reported. The helium ion flux was 10 μA (6.25×10^{13} atoms/sec) and the temperature range was from −175 to 700°C. One experiment was performed using a flux of 12.5×10^{13} atoms/sec at 500°C. (T.D.)

11211 ABSORPTION SPECTRUM OF GALLIUM ARSENIDE IRRADIATED WITH 5-MeV PROTONS. Krivov, M. A.; Red'ko, V. P.; Ramazanov, P. E.; Budnitskii, D. L. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 158-60(1972). (In Russian).

The absorption spectrum of gallium arsenide was determined after irradiation with fast protons, and the results were compared with those from irradiation with fast electrons, protons, and α particles. The effect of α particles was that of increasing the absorption somewhat more than in the case of protons. (K.S.W.)

Physical Properties

Refer also to abstracts 9902, 9922, 9924, and 10351.

11212 (AD–744499) POSITRON ANNIHILATION EXPERIMENTS AND THE BAND STRUCTURE OF V_3Si. Berko, S.; Weger, M. (Brandeis Univ., Waltham, Mass.). 1972. 20p. (AROD–3389:19-P). NTIS.

A specialized system is treated, using the positron annihilation method and a band calculation. From this work, it appears that the positron method may be very useful to investigate, at least, some specialized systems. Because this method is so time-consuming and expensive, it may prove desirable to perform a computer-simulated "positron experiment" prior to an actual experiment. (auth)

11213 (CEA-R–4358) STUDY OF THE RESISTIVITY OF URANIUM DIOXDE IN RELATION TO ITS MICROSTRUCTURE. Rubio,Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sep 1972. 130p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis submitted to Paris Univ. (France).

The resistivity of uranium dioxide at room temperatures was studied in terms of its microstructure. Experiments were performed both before and after heating under vacuum, large temperature gradients being considered. The different parameters likely to affect the resistivity of the UO_2 under the conditions considered (grain size, pores, stoichiometry) were examined. The cylindrical samples used had an O/U ratio between 2.001 and 2.006, and a density greater than 95% of the theoretical density. (auth)

11214 (CONF-721114–3) DIRECT MEASUREMENT OF CRYSTAL-FIELD SPLITTINGS IN PrN. Davis, H. L.; Mook, H. A. (Oak Ridge National Lab., Tenn.). 1972. 5p. Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Inelastic neutron scattering was employed to measure the crystal-field splittings of the $^3H_4$ ground multiplet corresponding to the Pr^{3+} ion in PrN. An analysis of the resulting data places the Γ_4 crystal-field level at 27.0 ± 1.0 meV, the Γ_3 at 46.3 ± 1.0 meV, and the Γ_5 at 91. ± 2. meV, above the ground Γ_1. These results can be quantitatively accounted for by a point-charge model with a charge of −3, which sharply contrasts with previous work of others that established the crystal-field levels in other PrX compounds (X = P, As, Sb, Bi, S, Se, Te) could be accounted for by point charges of −2. This difference between PrN and the other PrX compounds strongly implies some major difference in their electronic structures, which may indicate their being, respectively, semiconducting and metallic. (auth)

11215 (CONF-721114–4) NEUTRON SCATTERING STUDIES OF ^{147}Pm. Koehler, W. C.; Moon, R. M.; Child, H. R. (Oak Ridge National Lab., Tenn.). Oct 1972. 6p. Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Neutron scattering experiments were carried out on a polycrystalline rod of ^{147}Pm at temperatures ranging from 320 to 7.5°K. The double hexagonal close-packed structure characteristic of Pr and Nd was observed over this entire temperature range. Evidence for magnetic ordering in ^{147}Pm was sought in a variety of neutron scattering experiments. From conventional measurements it appears that any ordered moment must be less than about 0.4 μ_B. Neutron depolarization measurements indicate a small ferromagnetic moment at low temperatures and a transition temperature of about 98°K. The observations are qualitatively consistent with point-charge-model crystal-field calculations which predict a singlet ground state for ions on both hexagonal and cubic sites. (auth)

11216 (CONF-721114–5) MAGNETIC SCATTERING AMPLITUDES OF SAMARIUM. Moon, R. M.; Koehler, W. C. (Oak Ridge National Lab., Tenn.). Oct 1972. 6p. Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Approximate ground states for the cubic and hexagonal sites in metallic Sm are calculated. The cubic ground state is adjusted to give rough agreement with observed neutron scattering amplitudes for high-angle reflections. Large deviations occur at low scattering angles which are attributed to conduction electron polarization. The ratio of conduction spin polarization to 4f spin polarization is 0.15. (auth)

11217 (COO–2103-21) SPIN POLARIZED ENERGY BAND STRUCTURE, SPIN DENSITIES, AND THE NEUTRON MAGNETIC FORM FACTOR OF GADOLINIUM METAL. Harmon, B. N. (Northwestern Univ., Evanston, Ill. Dept. of Physics); Freeman, A. J. (Northwestern Univ., Evanston, Ill. Dept. of Physics, Argonne National Lab., Ill.). 1972. 5p. (CONF-721114–8). Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Conduction-electron spin densities and their contribution to the diffuse part of the neutron magnetic form factor of Gd metal measured by Moon et al., (Phys. Rev., B5: 997(1972)) were determined by means of spin-polarized APW calculations. Although the calculated spin density is similar to that of Moon et al., their large region of negative spin density cannot be reproduced. Thus, the theoretical form factor is considerably lower than experiment at the first (hkl) reflection. This may indicate the presence of other non-spin density contributions. (auth)

11218 (EUR–4891) MIGRATION OF ANION VACANCIES IN CaF_2 LATTICES AND IN MONOCLINIC ZrO_2. van der Voort, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov 1972. 80p. (In Dutch). Dep. NTIS (U. S. Sales Only). EUR FB 125.-.

Configurations of point defects in crystals are simulated by a computer program. In order to calculate the total potential energy of some configuration, use is made of generalized Born potentials. By minimizing this potential energy, the perturbed crystal may be relaxed. This yields a general working method in order to calculate migration energies of these point defects. This method is used to investigate the migration of anion vacancies in CaF_2 lattices and in monoclinic ZrO_2. (tr-auth)

11219 (LA-DC–72-1247) MAGNETIC PROPERTIES OF HoAg. Nereson, Norris (Los Alamos Scientific Lab., N. Mex.). [nd]. 5p. (CONF-721114–6). Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Neutron-diffraction measurements made on a HoAg powder sample exhibit superlattice reflections and confirm previous susceptibility data that antiferromagnetism develops below a Néel temperature of 33 ± 1°K. In the unannealed condition, the basic antiferromagnetic +-+- layer structure predominates in a tetragonal magnetic cell having adjacent (110) ferromagnetic planes with oppositely directed moments as in TbAg and DyAg. In the annealed state, the magnetic reflections consist solely of first-order satellite peaks of the basic magnetic reflections observed in the unannealed sample. One model for the magnetic ordering is a sinusoidally modulated transverse spin wave propagating in the ⟨100⟩ direction with the moments polarized in the c axis direction. The modulation wavelength of 6.6 ± 0.3 unit magnetic cells or 48 ± 2 Å is incommensurate with the unit cell and does not vary with temperature. The maximum ordered moment at the Ho atom sites is 8.0 ± 0.2 μ_B. The development of anti-ferromagnetic ordering with temperature conforms to an approximate Brillouin behavior with J = 2. (auth)

11220 (LA-DC–72-1282) MAGNETIC PROPERTIES OF MnB_2. Nereson, N.; Bowman, A.; Arnold, G. (Los Alamos Scientific Lab., N. Mex.). 1972. 5p. (CONF-721114–7). Dep. NTIS.

From 18th annual conference on magnetism and magnetic materials; Denver, CO (28 Nov 1972).

Neutron-diffraction measurements on powder samples of MnB_2 and 98% enriched $Mn^{11}B_2$ show superlattice reflections that can be indexed on a magnetic cell with a c-axis dimension twice that of the chemical cell. The basic magnetic structure is an antiferromagnetic layer type in which Mn spins are aligned parallel in each Mn layer and are coupled antiferromagnetically between adjacent layers. The presence of an (001) magnetic peak indicates that the moment is oriented perpendicular or at an angle to the c-axis. An excess intensity above that calculated for the (100) nuclear peak indicates a ferromagnetic moment is also present. The combined data from the antiferromagnetic and ferromagnetic reflections suggest a canted antiferromagnetic structure with an antiferromagnetic moment of 2.4 ± 0.3 μ_B per Mn atom and an angle of 45 ± 15° between the moment direction and the c-axis. The large errors on the results arise from the lack of a reliable nuclear pattern coupled with sample impurities and preferential orientation effects. Intensity versus temperature measurements of the (001) magnetic and (100) nuclear peaks indicate that the Néel temperature is 900 ± 100°C and that the sample decomposes rapidly at temperatures above 800°C. (auth)

11221 (NP–19600) MAGNETIC SPACE GROUPS OF MAGNETIC STRUCTURES DETERMINED BY NEUTRON DIFFRACTION. Kucab, M. (Institute of Nuclear Techniques, Krakow (Poland)). Apr 1972. 35p. (INT–25). Dep. NTIS (U. S. Sales Only).

A list of magnetic space groups (Shubnikov groups) of about five hundred magnetic structures is presented. A systematic and con-

cise algebraic description of those magnetic structures is given. (79 references) (auth)

11222 EXPERIMENTAL DETERMINATION OF THE COMPRESSIBILITY OF HYDROGEN AT DENSITIES 0.5 TO 2 g/cm³: METALLIZATION OF HYDROGEN. Grigor'ev, F. V.; Kormer, S. B.; Mikhailova, O. L.; Tolochko, A. P.; Urlin, V. D. JETP Lett. (USSR) (Engl. Transl.); 16: No. 5, 201-4(5 Sep 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 5, 286-90(5 Sep 1972).

The density of hydrogen was measured by a gamma-graphic method in the course of its isentropic compression by a cylindrical shell in the pressure range from 0.4 to 8 Mbar. The products of a cylindrical explosive charge accelerated a shell that compressed gaseous hydrogen to high densities and pressures. A high-power transmission gamma-graphic installation with a small exposure time was used to register the diameter of the cavity with compressed hydrogen. The density of the hydrogen can be determined by measuring the diameter of the cavity with the compressed gas during the process of convergence of the shell to the axis. By varying the initial pressure of the gas and the parameters of the discharge, it is possible to determine the compressibility of the hydrogen in a sufficiently wide range of densities. The experimental data allow for the determination of the equations of state of solid and liquid phases of molecular hydrogen. The data show that at 0.37 Mbar, the density of the hydrogen is 0.45; at 2.63, the density is 0.98; at 3.24, the density is 1.15; and at 8.00 Mbar, the density in g/cm³ is 1.95. (J.C.W.)

11223 CRYSTAL STRUCTURE OF Y_2ReB_6 AND ITS ANALOGS. Kuz'ma, Yu. B.; Svarichevskaya, S. I. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 3, 569-71(1972).

Translated from Kristallografiya; 17: No. 3, 658-61(1972).

The crystal structure of Y_2ReB_6 was investigated using the Laue and rotation methods. The x-ray diffraction patterns showed the structure to have rhombic symmetry. Unit-cell constants are tabulated for Y_2ReB_6 and its isostructural analogs R_2ReB_6 (R = Gd, Tb, Dy, Ho, Er, Tm, Lu). The Y_2ReB_6 structure is related to the $YCrB_4$ type; the constant a is $\sim a\sqrt{2}$ relative to $YReB_4$, and the constants b and c are virtually identical. Atomic coordinates and interatomic distances in the Y_2ReB_6 structure are tabulated. (D.L.C.)

11224 X-RAY-DIFFRACTION STUDY OF LAYER PACKING DEFECTS IN GRAPHITE STRUCTURES. Kurdyumov, A. V. (Inst. of Problems in Materials Science, Kiev). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 3, 534-8(1972).

Translated from Kristallografiya; 17: No. 3, 620-5(1972).

The influence of layer packing defects of different kinds in graphite structures on the broadening of the hkl lines was examined. An equation was obtained for determining the concentration of these packing defects from the broadening of several hkl lines with different indices. The change in the structure of graphites under the influence of pulse compression at a pressure of ~120 kbar was studied. It is shown that as a result of the compression there is a marked increase in the concentration of packing defects, particularly in natural graphite containing the rhombohedral modification in the original state; the dimensions of the ranges of coherent scattering remain practically unchanged. (auth)

11225 CRYSTAL STRUCTURE OF THE COMPOUNDS $YNiAl_4$ AND $YNiAl_2$. Rykhal, R. M.; Zarechnyuk, O. S.; Yarmolyuk, Ya. P. (Lvov State Univ.). Sov. Phys.-Crystal. (Engl. Transl.); 17: No. 3, 453-5(1972).

Translated from Kristallografiya; 17: No. 3, 521-4(1972).

The crystal structure of the compound $YNiAl_4$ was determined: it is a new structure type; space group Cmcm; a = 4.08, b = 15.44, c = 6.62 Å, Z = 4. The parameters for the atoms were found more accurately from a projection of the electron density; R = 15.0% from 69 0kl reflections. The crystal structure of $YNiAl_2$ belongs to the $MgCuAl_2$ type (space group Cmcm; a = 4.07, b = 10.13, c = 7.06 Å; Z = 4). The structure was found more accurately from projections; R = 14.3% from 44 0kl reflections. (auth)

11226 ELECTRON-DIFFRACTION STUDY OF THE ATOMIC STRUCTURE OF ORTHORHOMBIC TANTALUM OXIDE IN THIN FILMS. Khitrova, V. I.; Klechkovskaya, V. V.; Pinsker, Z. G. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 3, 442-7(1972).

Translated from Kristallografiya; 17: No. 3, 506-13(1972).

An orthorhombic tantalum oxide with lattice constants a = 5.47, b = 7.65, c = 26.10 Å, and a space group Pmmm not hitherto encountered is established by electron diffraction in thin-film samples. The structural determination is based on Patterson and Fourier syntheses. All the O atoms and most of the Ta atoms occupy their positions statistically with different probabilities. The composition of the compound is established by analyzing the heights of the potential peaks. A relationship is established between the structure of this orthorhombic oxide and the cubic tantalum oxides of the perovskite type. (auth)

11227 CRYSTAL STRUCTURE OF Ce_2NiSi AND RELATED COMPOUNDS. Bodak, O. I.; Gladyshevskii, E. I.; Mis'kiv, M. G. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 17: No. 3, 439-41(1972).

Translated from Kristallografiya; 17: No. 3, 502-5(1972).

The structure of Ce_2NiSi is of a new type ($P6_3/m$ group, a = 16.12, c = 4.309 Å, N = 40) and is a derivative of the $Rh_{20}Si_{13}$ structural type; the distribution of the Ni and Si atoms is partially disordered and corresponds to the formula $Ce_{10}NiX_3^{(1)}X_3^{(2)}Si_3$, where $X^{(1)} = Ni_{0.3}Si_{0.7}$ and $X^{(2)} = Ni_{0.7}Si_{0.3}$. The coordination numbers of the atoms are 14, 17, 17, and 20 for Ce, 8 for Ni, and 9 for Si, $X^{(1)}$, and $X^{(2)}$. The compound has a variable composition: $Ce_2Ni_{0.8-1.2}Si_{1.2-0.8}$. The structure was refined by the method of least squares; R = 15.2% for all independent hk0 reflections. The existence of the isostructural compounds La_2NiSi (a = 16.34, c = 4.322 Å) and Pr_2NiSi (a = 16.05, c = 4.302 Å) was established. (auth)

11228 GALVANOMAGNETIC PHENOMENA IN THIN FILMS OF MOLYBDENUM, YTTRIUM, AND SCANDIUM. Stasyuk, Z. B.; Panchishin, R. S.; Mel'nichuk, B. L. (Lvov State Univ.). Fiz. Metal. Metalloved.; 34: No. 1, 48-53(Jul 1972). (In Russian).

The influence of the classical size effect of thin films of Mo, Y, and Sc on their electric conductivity and Hall effect was studied. A two-zone model is used in explaining the results observed, and the dimensional effect is interpreted on the basis of the theories of Fuchs (1938) and Sondheimer (1952). (tr-auth)

11229 ELECTRON SCATTERING PROCESSES IN THE THERMODYNAMICS OF METALS IN NORMAL AND SUPERCONDUCTIVE STATES. Makarov, V. I.; Volynskii, I. Ya. Fiz. Metal. Metalloved.; 34: No. 1, 200-2(Jul 1972). (In Russian).

The effect of scattering processes was investigated in the system In–Hg in connection with changes in the topology of the Fermi surface. The thermodynamic quantity dT_k/dp was measured as functions of ρ and of Δn for the systems: In–Hg, In–15 at.% Hg–Pb, and In-3 at.% Hg–Pb. The experimental results showed that the scattering processes have no effect on the thermodynamic properties of a superconductor even in the case of change in the topology of the Fermi surface under the influence of impurities. (K.S.W.)

11230 MAGNETIC PROPERTIES OF $Mn_{3-x}Ni_xB_4$ IN STRONG MAGNETIC FIELDS. Timoshchuk, V. I.; Fakidov, I. G. (Inst. of Metal Physics, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1424-7(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1651-4(Jun 1972).

The magnetic properties of some borides of the $Mn_{3-x}Ni_xB_4$ system ($0.1 \leq x \leq 0.35$) were investigated in static and pulsed magnetic fields up to 300-kOe intensity. The spontaneous magnetization which appeared at a temperature Θ was several times smaller than the magnetization of the antiferromagnetic compound Mn_3B_4, which had been investigated earlier in strong magnetic fields. The saturation magnetization of the borides was not reached in fields up to 300 kOe. Information on the nature of the magnetic transitions occurring in the boride system was deduced from the results. (auth)

11231 MAGNETIC SUSCEPTIBILITY OF HOLMIUM NEAR THE NEEL POINT. Boyarskii, L. A.; Starikov, M. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1588-9(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1833-5(Jun 1972).

The susceptibility χ of polycrystalline Ho was measured at 110 to 250°K. Above 140°K, χ obeyed the Curie–Weiss law with the parameters $\theta = 82.0 \pm 1.0$°K and $\mu_{eff} = 11.1 \pm 0.1\ \mu_B$. The temperature coefficient of χ has a logarithmic divergence near the Neel point (~132°K). The equation $[d(\chi T/dT)] = a + b\,(T_N - T/T_N)^{\alpha}$ was used to analyze the experimental data. Best agreement was obtained for $T_N = 131.85 \pm 0.05$°K and $\alpha = 0.08 \pm 0.05$. (D.L.C.)

11232 MAGNETIC PROPERTIES OF COBALT–RARE EARTH THIN FILMS. Bendson, S. A. Minneapolis; Univ. of Minnesota (1972). 199p. University Microfilms Order No. 72-27,831.

Thesis.

A study was made of the magnetic properties of thin films over the whole range of composition from pure Co to 70 at.% Gd and from pure Co to 35 at.% Sm. These samples were deposited by triode sputtering in 10^{-3} Torr of argon. The film thicknesses varied from 1000 to about 5000 Å but contained about the same amount of Co in each sample. Tabulations of magnetic properties

for each compositional series include magnetic moment density, hysteresis loop squareness, coercivity, and rotational hysteresis loss integral. The magnetic moment density as a function of increasing Sm uniformly decreases from 161 Emu/gm for pure Co to a value nearly zero for compositions of about 30% Sm. For Gd, the magnetic moment density shows an almost linear decrease with increasing Gd with a minimum at ~22 at.% Gd. For samples of increased Gd content, this minimum is followed by an increase in the magnetic moment density reaching a broad peak near 40 at.%. Increased Gd content decreases the moment density until the samples become paramagnetic at 80 at.% Gd. The moment densities for the films agree well with the data published for bulk samples of similar compositions. The coercivities of the thin film samples are generally in the range of 200 Oe, but for three specific compositions, the coercivity becomes extremely large. These compositions are ~ 13 and 33 at.% Gd in the Co–Gd system and 20 to 25 at.% Sm in the Co–Sm system. Hysteresis loop squarenesses were measured on all of the samples. In the range of compositions from 5 to 15% Sm or Gd, squareness of 0.7 to 0.85 was recorded. These values are those predicted for hexagonal crystals with easy directions in the basal plane. The measured squarenesses decrease in both systems with increasing rare-earth content. The values approach zero when the lower moment densities are reached. The rotational hysteresis results are conclusive only for the 5 to 15% Sm samples. These films exhibit wall motion reversal but the reversal mechanism in the other films is not simply walls. All of the samples in the Sm–Co series displayed rotational hysteresis losses which did not reach a maximum value in the 0 to 10 kOe field range available. This same phenomenon occurs in the 10 to 25 at.% Gd range in the Gd–Co series. The torque curves verify the samples to be a random distribution or crystallites because of their isotropic nature. This crystallite randomness was also observed in the electron microscope. The crystallites were approximately spherical and decreased in size with increasing rare-earth content from 500 Å maximum for Co to less than 100 Å in 18 at.% Gd. (TSS) (Diss. Abstr. Int., B)

11233 HIGH-TEMPERATURE ENTHALPIES OF BINARY DODECABORIDES. Mar, R. W. (Sandia Labs., Livermore, CA); Stout, N. D. J. Chem. Phys.; 57: No. 12, 5342-9(15 Dec 1972).

Enthalpies of three dodecaborides were determined from 1300 to 2200°K by a drop calorimetric technique. The enthalpies were fitted with the Shomate function to give $Zr_{0.6}Y_{0.4}B_{12}$: $H_T - H_{298} = 4.204 \times 10^1\ T + 1.260 \times 10^{-2}\ T^2 - (2.528)\ 10^6\ T^{-1} - 5.175 \times 10^3$ cal/mole, ErB_{12}: $H_T - H_{298} = 3.947 \times 10^1\ T + 1.357 \times 10^{-2}\ T^2 - (2.706)\ 10^6\ T^{-1} - 3.896 \times 10^3$ cal/mole, UB_{12}: $H_T - H_{298} = 4.232 \times 10^1\ T + 1.399 \times 10^{-2}\ T^2 - (2.430)\ 10^6\ T^{-1} - 5.713 \times 10^3$ cal/mole. Minor differences between the enthalpies of these dodecaborides were analyzed and correlated with different electronic conduction contributions, which can be predicted from the valence states of the metal atom. The metal atoms achieve their usual chemical valency by donating two electrons to the boron lattice and the remainder to a conduction band. The uranium atoms in uranium dodecaboride appear to exist in the +5 and/or +6 states, whereas the +3, +4, and +3 states of erbium, zirconium, and yttrium are most probable. (auth)

11234 LOW-TEMPERATURE THERMAL-CONDUCTIVITY MEASUREMENT OF PHONON–MAGNETIC INTERACTIONS IN ERBIUM OXIDE. Rilling, K. F. Tempe, AZ; Arizona State Univ. (1972). 82p. University Microfilms Order No. 72-30,136. Thesis.

The thermal conductivity of single-crystal Er_2O_3 was measured from 1.2 to 100°K in both zero and nonzero magnetic fields. The zero magnetic field data had anomalies at 3.4°K and 35°K. The 3.4°K anomaly was associated with the critical fluctuation scattering of the Er_2O_3 antiferromagnetic transition which occurs at 3.4°K. The 35°K anomaly was associated with spin–phonon resonant scattering of the crystal field-split ground-state energy levels of the erbium ion. An imaginary lattice thermal conductivity which had no magnetic–phonon interactions was constructed from the Callaway Theory of Thermal Conductivity using boundary, point defect, and Umklapp scattering relaxation times. Then the zero magnetic field data was fitted by adding a critical fluctuation scattering relaxation time and a spin–phonon scattering relaxation time. The spin–phonon scattering relaxation time was the Orbach spin–phonon relaxation term with a Gaussian line shape. The Gaussian was very sensitive to the bandwidth which was taken from far-infrared data. This scattering term had essentially no adjustable parameters. It was found that the ground state to the first excited state spin–phonon resonant scattering transition had to be weak compared to other transitions to fit the data. The main spin–phonon scattering transitions were between the ground state and the 75, 88, and 159 cm^{-1} levels. To get a better fit to the zero magnetic field data the bandwidth of the Gaussian line shape was taken to be a linear function of temperature. Thermal conductivity–magnetic isofields were measured at 24, 41, and 59 kG. These were interpreted in a qualitative manner. The interpretation was that the magnetic field caused a saturation of the spin system which removed the critical fluctuation scattering and that the Zeeman splitting of the eight ground state doublets created a large number of new spin–phonon resonant scattering transitions. (Diss. Abstr. Int., B)

11235 GIANT SUSCEPTIBILITIES OF La–Gd. Kok, W. C. (Cambridge Univ., Eng.). Phil. Mag.; 26: No. 6, 1345-57(Dec 1972).

Giant susceptibilities were observed in some crystalline systems containing Gd impurity. The inverse magnetic susceptibility, however, conforms to the general pattern of dilute alloys of Cu–Mn type, where local moments interact via Ruderman–Kittel–Yosida indirect exchange but there is no long-range magnetic ordering: the susceptibility is Curie–Weiss in the limit of high temperatures, but departs from such behavior at lower temperatures to yield a peak susceptibility, χ_{max}, which is typically less than $\chi_{Curie-Weiss}$. This deviation is studied by assuming the existence of statistical fluctuations that arise from a random impurity distribution. A formula for the paramagnetic susceptibility of random alloys, valid to very low temperatures, is developed (with specific application to La–Gd), including external field effects. (UK)

11236 STUDY OF CHARGE DENSITY IN BERYLLIUM. Brown, P. J. (Cambridge Univ., Eng.). Phil. Mag.; 26: No. 6, 1377-94(Dec 1972).

The x-ray structure amplitudes for the 27 lowest-angle Bragg reflections of beryllium metal were measured on an absolute scale. These were used to deduce the charge density. The measured structure amplitudes were compared with those predicted both by the free-atom Hartree–Fock wave functions and by a free-electron orthogonalized plane-wave model. For both models, the predicted value for the lowest-angle reflection was close to that observed, but the structure amplitudes of subsequent reflections given by the models were significantly greater than those observed. To account for these discrepancies, a model of beryllium involving 2p-like tight binding functions is proposed. (UK)

11237 MAGNETIC AND ELECTRICAL PROPERTIES OF PURE α-CERIUM AT ATMOSPHERIC PRESSURE. Grimberg, A. J. T.; Schinkel, C. J.; Zandee, A. P. L. M. (Univ., Amsterdam). Solid State Commun.; 11: No. 11, 1579-83(1 Dec 1972).

The magnetization of "pressure-prepared" samples of α-cerium is reported as a function of temperature (1.7 to 80°K) and of magnetic field (up to 320 kOe) and the electrical resistivity as a function of temperature (1.4 to 25°K). According to the results, α-cerium appears to be a weakly exchange-enhanced paramagnet having a pronounced structure in the density of states curve at the Fermi level. (auth)

11238 LOW-TEMPERATURE THERMOMAGNETIC EFFECTS IN GRAPHITE. Jay-Gerin, J. P. (McGill Univ., Montreal). Can. J. Phys.; 50: No. 20, 2444-50(15 Oct 1972).

The low-temperature thermoelectric power (TEP) and the Nernst–Ettingshausen (NE) coefficient of graphite due to phonon drag are studied in the presence of a magnetic field H directed along the c axis and small enough for the quantum-mechanical character of the motion of the carriers to be negligible. Expressions for the TEP and the NE coefficient are obtained on the basis of the theory of Jay–Gerin and Maynard, in which the phonon-drag TEP of graphite in the absence of a magnetic field is linked with the Kohn screening anomaly. The results suggest a method by which information might be obtained about the strength of the electron– and hole–phonon coupling directly from experiment. A satisfactory agreement is found with the measurements of Takezawa, Tsuzuku, Ono, and Hishiyama and of Tamarin, Shalyt, and Volga. (auth)

11239 ELECTRICAL PROPERTIES OF SOLIDS: SURFACE PREPARATION AND METHODS OF MEASUREMENT. Connolly, T. F. (ed.). Solid State Physics Literature Guides, Volume 4. New York; Plenum Publishing Corporation (1972). 117p. $14.50.

This bibliography contains ~2,000 references from 1960 to mid-1970 on surface preparation and examination, contacts, resistivity and conductivity, inorganic dielectrics, and Hall effect. Emphasis is on semiconductors, but metals, alloys, insulators, and dielectrics are also included. Brief commentaries on dielectric measurements and contacts are also given. (D.L.C.)

11240 BALTIC SYMPOSIUM ON THE PHYSICS OF IONIC CRYSTALS, SEPTEMBER 25–9, 1971 (ABSTRACTS). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 2, 114-22 (1972). (In Russian). (CONF-710969–Absts.).

Abstracts are presented for 22 papers in the field of crystal physics, covering a number of topics and including diffusion and radiolysis, photo- and thermal stimulation, migration of holes,

luminescence, and point defect theory. The particular crystals studied were: KCl(Tl), KI(Tl), KI(Ag), CsI, KCl(In), CsI(Na), and CsBr(In). The migration of ^{36}Cl and ^{22}Na atoms under the influence of a beam of 3- to 5-MeV electrons was described. (K.S.W.)

11241 K X-RAY ABSORPTION SPECTRA OF ZIRCONIUM WITH INCORPORATED PHASES OF ZrB_2, ZrC, AND ZrN. Petrov, E. V.; Tsvetkov, V. P. Metallofizika; No. 40, 98-103(1972). (In Russian).

K-absorption spectra were recorded of the second order of reflection from a plane crystal of quartz (1122). The distortion function was equal to 4.5 eV. The spectra were treated according to the theory of short-range order. A parameter n_s was introduced in order to take account of the different scattering ability of the components of a compound. The value of this parameter for the compounds investigated coincided with the number of weakly bound valence electrons of the atom. (tr-auth)

11242 THEORY FOR THE ANOMALOUS THERMAL PROPERTIES OF URANIUM DIOXIDE. Oyanna, G. K. Rochester, NY; Univ. of Rochester (1972). 194p. University Microfilms Order No. 72-28,783.

Thesis.

The anomalous thermal properties of uranium dioxide were observed near and above the Neel temperature T_N. The specific heat exhibits a narrow peak with a width of about 6°K and centered at T_N = 30.5°K while the thermal conductivity shows an anomalously wide dip around T_N with a width of approximately 50 to 60°K. Already at about 200°K the thermal conductivity starts to become anomalously small compared, for example, to what is normally observed in insulators and other antiferromagnets. If it is assumed that the anomalously wide dip in the thermal conductivity K around T_N arises from the elastic scattering of phonons by (spin fluctuations) magnetic energy density fluctuations, then the resulting Rayleigh scattering formula for the phonon mean free path predicts indeed a dip in the thermal conductivity around T_N, but in sharp disagreement with experiment the width of this predicted dip turns out to be of the same order as the width of the peak at T_N observed for the specific heat. To explain this discrepancy between the observed and the theoretically predicted temperature dependence of the thermal conductivity around the Neel temperature of uranium dioxide, it is proposed that the effect of the spin–lattice interaction present in uranium dioxide on its thermal conductivity and specific heat be studied. The dominant spin–lattice coupling in uranium dioxide arises from the Jahn–Teller distortion. By determining the strength of this spin–lattice interaction from the observed temperature dependence of the elastic constants, it is shown that the spin–lattice coupling is capable of explaining the observed anomalous temperature variation of the thermal conductivity around and above T_N. Also, by showing that the spin–lattice interaction energy due to the Jahn–Teller distortion is approximately temperature-independent, one can explain the sharp peak in the specific heat as magnetic in origin and that the Jahn–Teller distortion does not affect the specific heat C above T_N while at the same time it has a strong effect on K(T). Finally, the fact that the phonon mean free path l_{J-T} due to the Jahn–Teller spin–lattice interaction is nearly temperature-independent, while the phonon mean free path l_{anh} due to the anharmonic lattice forces is inversely proportional to T, explains obviously the fact that the effect of the spin–lattice coupling on K in antiferromagnets like UO_2, CoF_2, CoO, NiO, and MnF_2 is masked increasingly by anharmonicity for increasing T_N. (Diss. Abstr. Int., B)

11243 ADSORPTION OF H_2 AND OF N_2 ON (110)Mo. Mahnig, M.; Schmidt, L. D. (Univ. of Minnesota, Minneapolis). Z. Phys. Chem. (Frankfurt); 80: No. 1-2, 71-81(Aug 1972).

The binding states and desorption and condensation kinetics of H_2 and N_2 on the (110) plane of Mo are examined using flash desorption mass spectrometry, and the results are compared with previously obtained data on (100) Mo and on (110) W. There are two atomic states of hydrogen on (110) Mo. Saturation densities are 7×10^{14} atoms cm^{-2} in each state. The activation energies of desorption are estimated to be 28 and 34 kcal $mole^{-1}$, considerably higher than on (100) Mo. The sticking coefficient was almost independent of substrate temperature for 78 < T < 300°K and exhibited a break upon saturation of the high temperature state. Nitrogen desorbs as a single atomic state with a saturation density of $\sim 2 \times 10^{14}$ atoms cm^{-2} and a desorption activation energy of 81 kcal $mole^{-1}$. The sticking coefficient varies with coverage as $(1-\theta)^2$, and the initial sticking coefficient is ~0.09. The coverage dependence is the same as on (110) W, but s_0 is much higher. Results show that there is complete correspondence in the states and their kinetics between the (110) planes of W and Mo but that the chemical nature of the substrates is important in determining the parameters. Also the crystallographic anisotropies between the (110) and (100) planes differ considerably for the two substrates. (auth)

11244 INVESTIGATION OF THE POSITIVE-ION EMISSION OF TUNGSTEN FILAMENT WITH A TIME-OF-FLIGHT MASS SPECTROMETER. IV. Kaposi, Oliver; Riedel, Miklos; Kabdebo, Gyoergy. Magy. Kem. Foly.; 76: No. 12, 670-6(Dec 1970). (In Hungarian).

The temperature dependence of the emission of tungsten filaments produced with different additives was investigated. The emission curves exhibited two maxima. The activation energy values derived from these curves led to the conclusion that the first maximum must be due to the desorption of alkaline impurities on the surface, whereas the second maximum in ion emission observed above 2000°K can be attributed to the increased grain-boundary diffusion brought about by the recrystallization of tungsten. The heating of annealed, recrystallized tungsten resulted in ion currents that were smaller by some orders of magnitude than the former ones, and the temperature dependence of the emission was also dissimilar. In this case—in the environment of 1800 and 2100°K—transient maxima were observed that could be attributed to the ion-emission-increasing effect of residual gases. Above 2500°K the ion current increased again with raising of the temperature, and by virtue of the activation energy value (~120 kcal/mol) this phenomenon pointed to the volume diffusion of alkali metals. (auth)

11245 THERMO-EMISSIVE PROPERTIES OF BORIDES OF THE TRANSITION METALS OF GROUPS IV TO VI IN RELATION TO THEIR ELECTRONIC STRUCTURE. Samsonov, G. V.; Fomenko, V. S.; Kunitskii, Yu. A. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 4, 41-5(1972). (In Russian).

The thermo-emissive properties of borides of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, and W were investigated by powder metallurgy methods in the temperature range 1,300 to 2,100°K. A correlation between the work function of the transition metal borides and some physical properties of these compounds was established. A regularity in the change in physical properties was explained in the light of electron structure of the borides. (tr-auth)

Moessbauer Effects and NMR

Refer also to abstracts 9675 and 10953.

11246 MOESSBAUER EFFECT STUDY OF THE LATTICE DYNAMICS OF IRON IMPURITIES IN Al, Rh, Pd, V, AND Mo METALS. O'Connor, D. A.; Reeks, M. W.; Skyrme, G. (Univ. of Birmingham, Eng.). J. Phys., F (London); 2: No. 6, 1179-88 (Nov 1972).

The recoilless fraction and second-order Doppler shift of the Moessbauer line in iron-57 present as an impurity in Al, Rh, Pd, V, and Mo metals was measured in the range 4 to 1000°K. Values of the weighted mean lattice frequencies for the iron atoms were obtained and on the basis of a central-force nearest-neighbor model the iron–host force constant calculated. In all cases, the iron–host force constant was found to be less than the equivalent host–host force constant so that resonant band modes for the iron atoms would explain the results. (auth)

11247 INTERFERENCE OF HYPERFINE COMPONENTS IN THE SCATTERING OF gamma RADIATION BY MOESSBAUER NUCLEI. Ivanov, A. S.; Kolpakov, A. V. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 14: No. 6, 1537-8(Dec 1972).

Translated from Fiz. Tverd. Tela; 14: No. 6, 1787–9(Jun 1972).

Interference between electromagnetic waves scattered by different hyperfine structure components is considered for a Moessbauer nucleus in a crystal. If the nucleus has a magnetic moment, its interaction with the internal crystal will lead to a hyperfine splitting of the nuclear levels. Since the intermediate state in the scattering process is not known, interference terms may be expected in the equation for the intensity of scattered photons. Equations are derived for the square of the modulus of the scattering amplitude, which is averaged over the polarizations of the absorbed and emitted photons. The interference term is determined for $Y_1 = 1/2$ and $Y = 3/2$, and for $\theta = \theta' = \pi/2$ (source in y axis). The difference between intensities at φ' and $-\varphi'$ is twice the interference term at its extremum at $\varphi' = \pi/4\ (2p+1)$. (D.L.C.)

11248 NUCLEAR ACOUSTIC RESONANCE IN TANTALUM AT HIGH MAGNETIC FIELDS. Leisure, R. G.; Hsu, D. K.; Seiber, B. A. (Colorado State Univ., Fort Collins). Phys. Lett.; 42A: No. 3, 195-6(4 Dec 1972).

Nuclear acoustic resonance has been observed at much higher magnetic fields than previously reported for nonmagnetic materials. Marked differences between the $\Delta m = 1$ and the $\Delta m = 2$ line shapes in tantalum were noted. The experiments were carried out in the fields at 20 to 60 kOe. (auth)

PHYSICS (THEORETICAL)

Refer also to abstracts 10728 and 11259.

11249 NUMERICAL SOLUTION OF THE RADIAL SCHROEDINGER EQUATION. Beleznay, F. (Mueszaki Fizikai Kutato Intezete, Budapest). Comput. Phys. Commun.; 3: No. 4, 334-8 (Jul 1972).

The program SCHROD written in USASI FORTRAN for the CDC-3300 computer is described. Using this program the radial Schroedinger equation is integrated by means of the fourth-order Runge-Kutta method using a logarithmic mesh. The radial Schroedinger equation is used to determine the wave functions and phase shifts for Hartree-Fock-Slater type atomic and muffin-tin type band structure calculations. (J.F.P.)

11250 QUANTUM THEORY OF STATE REDUCTION AND MEASUREMENT. Fujiwara, Izuru (Osaka Univ., Sakai, Japan). Found. Phys.; 2: No. 2-3, 83-110(Apr 1972).

The central problem in the quantum theory of measurement, how to describe the process of state reduction in terms of the quantum-mechanical formalism, is solved on the basis of the relativity of quantal states, which implies that once the apparatus is detected in a well-defined state, the object state must reduce to a corresponding one. This is a process termed by Schroedinger disentanglement. Here, it is essential to observe that Renninger's negative result does constitute an actual measurement process. From this point of view, Heisenberg's interpretation of his microscope experiment and the Einstein–Podolsky–Rosen arguments are reinvestigated. Satisfactory discussions are given to various experimental situations, such as the Stern–Gerlack-type experiment, successive measurements, macroscopic measurements, and Schroedinger's cat. Finally, it is proposed to regard a state vector in quantum mechanics as an irreducible physical construct, in Margenau's sense, that is not further analyzable both mathematically and conceptually. (auth)

11251 DIRAC'S PRINCIPLE AND VARIABILITY OF FUNDAMENTAL CONSTANTS. Chechev, V. P.; Gurevich, L. E.; Kramarovskii, Ya. M. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 42B: No. 2, 261-3(27 Nov 1972).

A hypothesis is suggested of $e^4 \propto t$, $\hbar^2 \propto t$, G = const. which logically follows from Dirac's principle of large dimensionless quantities ($\sim 10^{40}$) being proportional to the age of the universe, t. Dirac's principle is generalized for both the weak and strong interactions, and corollaries are pointed out and treated in terms of the above hypothesis. (auth)

11252 NONRELATIVISTIC LIMIT OF ACTION-AT-A-DISTANCE RELATIVISTIC CLASSICAL MECHANICS. Wray, J. G. (Moorhead State Coll., MN). Nuovo Cim.; 12B: No. 2, 231-8 (11 Dec 1972).

A certain subset of solutions to the Currie–Hill covariance condition for relativistic classical mechanics of two particles is found to satisfy coupled nonlinear partial differential equations even in the nonrelativistic limit. For this class of forces, the equations of motion are the same whether equal-time or unequal-time surfaces are used, even in the nonrelativistic limit. (auth)

11253 MATRIX ELEMENTS OF THE RADIAL-ANGULAR FACTORIZED HARMONIC OSCILLATOR. Haskell, T. G.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, New Zealand). Nuovo Cim.; 12B: No. 2, 185-96(11 Dec 1972).

The radial wave functions of the harmonic oscillator are shown to form a basis for representations of the noncompact group $O_{2,1}$ in the scheme $Sp_{6,R} \supset O_{2,1} \times SO_3$. The tensor operators $T^{(k)}_q = r^{2k}$, where k may be integral or half-integral, are shown to transform simply under the action of the group generators and hence the matrix elements of $T^{(k)}_q$ may be calculated. A selection rule similar to that given by Pasternack and Sternheimer for hydrogenic matrix elements is derived. Some differences between the hydrogenic and harmonic-oscillator problems are noted. (auth)

11254 GROUP-THEORETICAL REPRESENTATION OF THE GENERALIZED HEISENBERG RELATIONS. Rauscher, E. A. (Univ. of California, Berkeley). Lett. Nuovo Cim.; 5: No. 14, 925-30(2 Dec 1972).

A group-theoretical interpretation of the generalized Heisenberg relations, which are a generalized network of pair relations as a generalized set of canonically conjugate variables obeying commutation relations in terms of universal constants, is presented. A generalized wave equation is constructed. (J.F.P.)

11255 COMMENT ON THE PAPER ENTITLED "ON THE POINCARE NONINVARIANCE OF A RECENT ALTERNATIVE TO THE DIRAC EQUATION." Biedenharn, L. C. (Duke Univ., Durham, NC); Han, M. Y.; van Dam, H. Lett. Nuovo Cim.; 5: No. 14, 967-8(2 Dec 1972).

A previous argument showing that the alternative equation to the Dirac equation lacks Poincare invariance is shown to be incorrect. (J.F.P.)

11256 QUANTIZATION OF A GENERAL DYNAMICAL SYSTEM BY FEYNMAN'S PATH INTEGRATION FORMULATION. Cheng, K. A. (State Univ. of New York, Stony Brook). J. Math. Phys. (N. Y.); 13: No. 11, 1723-9(Nov 1972).

The Schroedinger equation is obtained by Feynman's path integration method of quantization for a general dynamical system. The meaning of the results is discussed. (auth)

11257 FEYNMAN'S PATH INTEGRAL. DEFINITION WITHOUT LIMITING PROCEDURE. DeWitt, C. M. (Univ. of Texas, Austin). Commun. Math. Phys.; 28: No. 1, 47-67(1972).

Feynman's integral is defined with respect to a pseudomeasure on the space of paths: for instance, let C′ be the space of paths C $q : T \subset \mathbb{R} \to$ configuration space of the system, let C′ be the topological dual of C; then Feynman's integral for a particle of mass m in a potential V can be written $\int_C \exp(iS_{int}(q)/\hbar)dw(\sqrt{m}q)$ where $S_{int}(q) = \int_T V[q(t)]dt$ and where dw is a pseudomeasure whose Fourier transform is defined by $F\,w(\mu) = \exp(-iW(\mu)/2) = \exp[-(i/2)\int_T \int_T \inf(t,t')d\mu(t)d\mu(t')]$ for $\mu \in C'$. Pseudomeasures are discussed; several integrals with respect to pseudomeasures are computed. (auth)

11258 NOTE ON SOME INTEGRAL INEQUALITIES. Bargmann, V. (Princeton Univ., NJ). Helv. Phys. Acta; 45: No. 2, 249-57(1972).

Inequalities are derived for certain integrals which have the mathematical structure of quantum mechanical expectation values. (auth)

11259 QUANTUM THEORY OF MEASUREMENT AND MACROSCOPIC OBSERVABLES. Hepp, Klaus (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 45: No. 2, 237-48(1972).

The generation of probabilities from probability amplitudes in a quantum mechanical measurement process is discussed in the framework of infinite quantum systems. In several explicitly soluble models, the measurement leads to macroscopically different "pointer positions" and to a rigorous "reduction of the wave packet" with respect to all local observables. (auth)

11260 SYMMETRY OPERATIONS IN QUANTUM MECHANICS. Hunziker, Walter (Eidgenoessische Technische Hochschule, Zurich). Helv. Phys. Acta; 45: No. 2, 233-6(1972).

The discussion of symmetry operations in quantum mechanics covers a proof for dim H = dim H^1 = 2, where H and H^1 are complex Hilbert spaces, reduction to Wigner's theorem, and construction of a linear or antilinear isometry of H into H^1. (J.F.P.)

11261 NEW APPROACH TO QUANTUM STATISTICAL MECHANICS. Jaen, J. K. (Hanyang Univ., Seoul). J. Korean Phys. Soc.; 5: No. 1, 1-18(Mar 1972).

A reformulation of the fundamental principles of equilibrium statistical mechanics is more realistically presented by a new approach, more or less in line with the Boltzmann ergodic idea, which eliminates the excess assumptions and theoretical gap between the existing schemes of quantum mechanics and statistical mechanics, by analyzing more the close correspondence between classical and quantum mechanics and the dynamic behavior of the quantum state vector in the Fock space. No assumptions are made except an intuitively self-evident, a priori fundamental definition. This leads to the correct existing result. (auth)

11262 DIFFUSION FOR WEAKLY COUPLED QUANTUM OSCILLATORS. Davies, E. B. (Mathematical Inst., Oxford). Commun. Math. Phys.; 27: No. 4, 309-25(1972).

A simple model is constructed which exhibits some of the properties discussed by van Hove in his study of the Pauli master equation. The model consists of an infinite chain of quantum oscillators which are coupled so that the interaction Hamiltonian is quadratic. It is supposed that the chain is in equilibrium at an inverse temperature β, and the return to equilibrium when a

chosen oscillator is given an arbitrary perturbation is studied. It is shown that in the limit as the interaction becomes weaker and of longer range, the evolution of the chosen oscillator becomes a diffusion equation. Moreover an explicit example is given where the evolution of the chosen oscillator has the Markov property and where the Pauli master equation is exactly satisfied. (auth)

11263 ENTROPY AND NORMAL STATES. Manuceau, J. (Univ. de Provence, Marseille); Naudts, J.; Verbeure, A. Commun. Math. Phys.; 27: No. 4, 327-38(1972).

A generalized definition of entropy for any state on a C* algebra is given and studied. It is proven that the entropy characterizes uniquely the normal states. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

11264 (GULF-GA-A-12222) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1972. (Gulf General Atomic Co., San Diego, Calif.). 30 Sep 1972. Contract AT(04-3)-167. 113p. Dep. NTIS.

The High-Temperature Gas-cooled Reactor (HTGR) work reported includes studies of basic fission-product distribution mechanisms, recycle fuel studies (including designing and testing of recycle test elements) and exploration of head-end reprocessing methods (as part of a national recycle plan and of a recycle fuel plant), and physics and fuel management studies. Materials studies include irradiation and analysis of fuel particles in capsules to evaluate fuel systems, and basic studies of control materials and of carbon and graphite. Experimental procedures and results are discussed and, where appropriate, the data are presented. (auth)

11265 TRENDS IN NUCLEAR PRODUCT IMPROVEMENT. Hill, J. Atom (London); No. 193, 193-6(Nov 1972).

The world development of nuclear power during the past few years is first briefly reviewed, including safety, environmental, and social considerations. The basic problems that have faced the nuclear power industries are then discussed, including the long time before operating experience can be fed back into design. Problems include the following: what are the long-term effects of neutron irradiation on steel; how long will a graphite moderator last; what period of time will elapse before the fuel will start to swell; what are the long-term effects of corrosion; will repair be possible; and so on. In this connection accelerated tests are mentioned. In connection with the Magnox programme, the disadvantages of employing a consortium of a number of design companies are stressed, and it is thought that better results would have been obtained if there had been less competition and more replication, associated with a single stream of progressive improvement. This was better achieved in the AGR programme. With regard to the fast reactor, the problem arises as to how continuity of improvement can be obtained with several independent national programmes, a number of separate design teams, and a multiplicity of specialist equipment suppliers. The UK view is that the need for progressive product improvement, coupled with the great advantages of replication, are more important than any advantages of having separate companies in competition. It is necessary to develop improved Pu fuel and particularly fuel that is easier and cheaper to fabricate. Specialist suppliers are evolving in Europe to supply pressure vessels, heat exchangers, and other specialized components, and the centrifuge is being developed multi-nationally. In the diffusion process the French have taken the initiative and a number of other European countries have associated themselves, and the creation of United Reprocessors should enable the building of an efficient and economic reprocessing plant. (UK)

11266 LIQUID METAL FAST BREEDER REACTOR (LMFBR) DEMONSTRATION PLANT. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, SECOND SESSION, SEPTEMBER 7, 8, AND 12, 1972. Washington, DC; Joint Committee on Atomic Energy (1972). 275p. GPO $2.00.

The proposed cooperative arrangement between private and public organizations for the design, construction, and operation of the liquid metal fast breeder reactor demonstration plant is reviewed. (H.D.R.)

11267 FUTURE NUCLEAR POWER SYSTEMS. Landis, J. W. (Gulf General Atomic, Inc., San Diego, CA). J. Inst. Nucl. Eng.; 13: No. 6, 180-2(Nov 1972).

The shortcomings of present reactor systems are briefly reviewed and reasons given for the development of fast breeder and high temperature gas cooled reactors. The so-called problem of "thermal pollution" of lakes and rivers by light water reactors is mentioned, together with the problem of adequate cooling water supplies in some areas. The use of dry cooling towers is discussed, and it is stated that in order to make the best use of dry cooling the usual steam turbines must be replaced by closed cycle gas turbines; there is a great incentive to develop the closed cycle gas turbine for use with nuclear reactors. Comparisons are made between the functions and use of HTRs and fast breeders, and it is thought that future nuclear power systems may employ a mixture of both types. Major problems to be solved with these reactors are discussed; including the use of closed cycle gas turbines. The future of fusion reactors is also briefly discussed. International cooperation is emphasized for the whole field of nuclear power development. (UK)

11268 IMPORTANT SODIUM COOLED FAST BREEDER REACTOR PROGRAMS. Grenon, Michel. Rev. Fr. Energ.; 23: No. 245, 577-83(Sep 1972). (In French).

The principal programs involving sodium cooled fast neutron reactors in the world are reviewed. The characteristics of PFR in Great Britain, SNR in Germany, PEC in Italy, BN 350 and BN 600 in the Soviet Union, and FFTF in the United States are given. (France)

11269 NUCLEAR ENERGY'S TOMORROW. Shaw, Milton (Atomic Energy Commission, Washington, DC). pp 18,5-7 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

A meaningful examination of the future of nuclear energy requires that the present status of development of nuclear power and industrial and utility commitments be considered in context with the established developmental program for advanced reactors. The Nation's advanced reactor program, which is concentrated on the Liquid Metal-Cooled Fast Breeder Reactor (LMFBR), is progressing according to a carefully developed plan involving the cooperative efforts of the nuclear power equipment manufacturers, the electric power utility industry, and the United States Atomic Energy Commission (USAEC). The LMFBR and other advanced reactors offer, in addition to the economic incentive of unlimited low cost electric power for the future, the advantage of higher thermal efficiency which, when coupled with other technical developments, will reduce the environmental impact of nuclear plants to an even lower level than that achieved by the currently commercial Light Water Cooled Reactors. (auth)

11270 ENVIRONMENTAL AND REGULATORY ASPECTS OF THE BREEDER REACTOR. Doub, W. O. (Atomic Energy Commission, Washington, D. C.). Environ. Aff.; 2: No. 1, (1972).

A historical resume is given of the LMFBR program in the United States. The demonstration plants and support facilities presently planned are discussed, and some of the economic and fiscal aspects are considered. The environmental impact of the breeder is considered, and it is suggested that the breeder could lead to the virtual elimination of air pollution from nonmobile energy sources. Safety problems (plutonium and sodium management) are also considered briefly. Regulation and the responsibilities of the U.S.A.E.C. are discussed. (D.L.C.)

11271 NUCLEAR ENERGY AND THE FUTURE. Andrzejewski, S. Nukleonika; 16: No. 9, 399-409(Oct 1971). (In French).

The increasing energy needs of the industrial nations is indicated, and the energy sources available are discussed. Problems connected with the traditional energy sources and their reserves have led to the rapid acceleration of the installation of nuclear energy. The advantages of nuclear power plants are summarized. (J.S.R.)

11272 DEVELOPMENT OF A THERMAL BREEDER REACTOR IN THE NETHERLANDS. Went, J. J. Mitt. VGB; 51: No. 6, 431-6(Dec 1971). (In German).

The necessity for a comparison between fast and thermal breeder reactors is discussed. The advantages and disadvantages which make the development of an alternative thermal breeder reactor appear very desirable are enumerated. Then follows a brief description of the development of the fission material and of the reactor systems. (auth)

Physics and Core Engineering

11273 (AI-AEC-13040) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, July-September 1972. (Atomics International, Canoga Park, Calif.). 15 Nov 1972. Contract AT(04-3)-824. 15p. Dep. NTIS.

LIQUID METAL FAST BREEDER REACTOR—physics measurement programs during July to September 1972
NEUTRON CROSS SECTIONS—calculations for fast reactors, evaluation of ENDF/B data for, (E/T)
REACTORS, FAST—physics analysis of, development of IMPS and VIM codes for

TUNGSTEN—neutron cross sections for, evaluation of ENDF/B data for, (E/T) (H.D.R.)

11274 (EURFNR-1047) PHYSICS INVESTIGATIONS OF SODIUM COOLED FAST REACTORS: CORE Z1 MASURCA IN SNEAK-ASSEMBLY 6D. Hammer, Philippe (comp.) (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Plum, Fritz (comp.) (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Systemtechnik und Reaktorphysik). Sep 1972. 89p. (CEA-N-1561; KFK-1581). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The results of the measurements performed on the plutonium core Z1 MASURCA built in the SNEAK 6D facility at Karlsruhe during 1970 are presented. This core simulates the central zone of a 250 MW(e) power fast reactor. The experiments were carried out in close cooperation between Karlsruhe and Cadarache physicists according to a common program settled by the two laboratories and devoted to the study of two kinds of parameters: (1) cell parameters (spectrum–material buckling–spectral indices), characterizing the Z1 MASURCA cell, which allow a check on the validity of the cross-section sets for predicting the neutron balance in such a medium. (2) design parameters (critical mass–sodium void–power distribution γ heating-control rods) which are studied in order to check and eventually to improve the calculation methods used to predict those quantities for the present designs (PHENIX–SNR). 14 references. (auth)

11275 NUCLEAR REACTOR COLUMNS. Williams, M. R. L. (to British Nuclear Design and Construction Ltd.). British Patent 1,279,965. 28 Jun 1972. Filed 23 Aug 1968.

Reference is made to fluid-cooled reactors of the kind using a moderator core built up of a number of columns arranged vertically and in a lattice pattern, and containing cooled fuel channels. These columns have to be removed periodically for refuelling and because of moderator deterioration, and this may lead to coolant leakage, coolant flow, and pressure drop problems. In the arrangement described, each column comprises an inner stack of blocks located within aligned holes formed in the blocks of an outer stack, the blocks of each inner stack being staggered vertically in relation to the blocks of the respective surrounding outer stack, with a radical clearance between the two stacks sufficient to facilitate assembly of the column in the core and allow for any differential growth or contraction which might arise under irradiation; this clearance is, however, small enough to allow blocks of the inner stack to abut adjacent blocks of the outer stack on application of a transverse load above a predetermined value to the column during reactor operation. In this arrangement, a moderator column is provided that may conveniently be removed from the reactor core and in which the danger of transverse buckling or collapse under the influence of a transverse pressure drop across the column is less than would be the case if the column simply consisted of blocks stacked one upon another and spigoted together at their ends. (UK)

11276 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Yellowlees, J. M.; Heaton, J. F.; Boler, R. (to Nuclear Power Group Ltd.). British Patent 1,286,265. 23 Aug 1972. Filed 14 Apr 1969.

Reference is made to the reaction of graphite with water vapor in reactors. In reactors in which the coolant passes through a boiler to raise steam the possibility of water leakage into the coolant cannot be eliminated, and this may cause an unacceptably high corrosive rate of the graphite, particularly in high-temperature regions. The system described provides a means for removing water vapour leaking into a reactor core by the use of "gettering" material, located in the reactor core. Suitable materials are Zr and Ti in elemental or alloy form; U could also be used. The "gettering" material may be in tube form and placed in high temperature regions of the core accessible to the fuel handling machine to permit insertion and withdrawal. The tubes may be pinned to increase the surface area, and a preferred location is in that part of the core acting as a neutron reflector at the coolant outlet end. The tubes may be removed individually, or a complete reflector block housing the tubes may be changed. (UK)

11277 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Skinner, R. A.; Heaton, J. F. (to Nuclear Power Group Ltd.). British Patent 1,286,264. 23 Aug 1972. Filed 13 Sep 1968.

Reference is made to gas-cooled graphite reactors. Where the coolant is circulated through a boiler to raise steam there is a possibility of water vapour being carried into the core, where it reacts with the graphite. Over a certain temperature range, the rate at which water vapour reacts with graphite increases with temperature, and there is a risk that graphite in the hotter regions of the core will suffer attack beyond acceptable limits. In the system described, the graphite in the cooler regions of the core incorporates a catalyst that increases the rate of reaction with water vapour, thereby reducing the risk of attack in the hotter regions exceeding acceptable limits, and allowing a higher level of water vapour in the coolant to be tolerated. The graphite may be impregnated with the catalyst during or after manufacture, or may be coated therewith, and the type of catalyst used and its concentration will depend on circumstances. The preferred method for a typical high-temperature reactor with He coolant, graphite moderator, and graphite fuel containers is to impregnate some or all of the moderator blocks with Ba at approximately 500 ppm. The Ba may be introduced by an aqueous salt solution, by oxide, or by a Ba vapour process. Factors affecting reaction between graphite and water vapour are discussed, particularly in regard to the optimum use of the catalyst. (UK)

11278 CRITICALITY CONDITIONS FOR A FINITE HOMOGENIZED NATURAL-URANIUM FUELED REACTOR WITH PRESCRIBED THERMAL NEUTRON FLUX. Zezula, R. (Charles Univ., Prague). Apl. Mat.; 15: No. 5, 328-38(1970).

A mathematical formulation is presented, in a two-group diffusion approximation and for multidimensional geometries, of the calculation of fuel concentration in the core of a finite homogenized natural-uranium reactor at a prescribed thermal neutron flux. The conditions are shown which are sufficient for a single solution to exist; in the special case of a flattened thermal neutron flux in the reactor core ($\phi = \phi_0 = \text{const.}$) this leads to a minimum critical mass. (NSA of Czech.)

11279 SUPPORT FOR NUCLEAR REACTOR. Patarin, L. (to Commissariat a l'Energie Atomique). French Patent 2,108,896. 26 May 1972. Filed 16 Oct 1970. (In French).

A support for the core of a high-temperature reactor is described. A concrete vessel encloses the reactor core which rests on this support. The support consists of a series of prismatic slabs arranged in different layers on the bottom of the vessel. These slabs are composed of a refractory insulating material. (France)

11280 LIQUID METAL COOLED NUCLEAR REACTOR. Ventre, E. (to Electricite de France). French Patent 2,112,044. 16 Jun 1972. Filed 5 Aug 1970. (In French).

A liquid metal-cooled reactor with an integrated heat exchanger is described. It consists of a vessel containing the coolant and provided with a lid possessing at least one sleeve which extends the vessel upwards. This sleeve has a cross section less than that of the vessel. A special device maintains the free surface of the coolant inside the sleeve (or sleeves). This device consists of a recipient with an opening towards its lower end and is immersed in the coolant. Means are provided for introducing a gas (inert with respect to the coolant) into the upper part of the recipient and also for allowing it to escape from this recipient. (France)

11281 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Barker, A.; Perks, M. A. (to United Kingdom Atomic Energy Authority). British Patent 1,285,464. 16 Aug 1972. Filed 8 Aug 1969.

Reference is made, in particular, to fast breeder reactor cores. In such cores there is a considerable variation of neutron flux from the control regions, where flux is at a maximum, to the outer breeder regions where flux is minimum. This gives rise to a large power variation across the core, with the result that the mean power output can be relatively low. The disadvantages of conventional "flattening" methods are stated, and the object of the arrangement described is to obviate or reduce these disadvantages, and also provide some other advantages. In this arrangement the core comprises an array of fuel members arranged in inner and outer zones. The fuel members constituting the inner zone are longer and more widely spaced than those constituting the outer zone, and the variation of power output across the core is reduced. Such a configuration also enables a high mean coolant outlet temperature to be achieved without the need for coolant flow variation across the core. Inner, intermediate, and outer core zones may similarly be provided, with breeder membranes located in positions surrounding the outer zone and at axial positions at the ends of the three zones. (UK)

11282 MODERATOR BLOCKS FOR FLUID-COOLED NUCLEAR REACTORS. Joyce, A. J. (to British Nuclear Design and Construction Ltd.). British Patent 1,279,654. 28 Jun 1972. Filed 29 Aug 1969.

The arrangement described is claimed to have particular application where the moderator of a nuclear reactor comprises hexagonal columns arranged with their axes in an equilateral triangular array, and it is particularly concerned with the provision of fuel channels in such columns. In the design of fuelled moderator blocks for low enriched High-Temperature Reactors, a problem arises in arranging the fuel channels within the hexagonal cross section so that a sufficiently low moderating ratio is achieved. In the arrangement described the moderator block has a number of identical parallel channels extending through it, and in each of those segmental areas bounded by three radii at 120° to one another the fuel channels are disposed, in a regular triangular pattern, in rows parallel to the three radii. Those channels that in any one of the segmental areas are nearest to one of the two radii bounding that area are positioned so that they form a square pattern with the nearest channels in the segmented area on the other side of that radius. The block is conveniently of hexagonal cross section and contains 24 channels. One additional channel may be provided at the center of the block to receive a control rod. Alternatively, there may be provided at the center of the block an additional channel for moderator handling means. In the latter case, where the block is of hexagonal cross section, a longitudinal groove may be provided in one corner of such shape that when the block is positioned adjacent to two other blocks having similar grooves a space is provided for receiving a control rod. Keying features may also be provided. A channel may also be provided for a burnable poison rod. (UK)

11283 REACTOR PHYSICS AND STUDIES OF PROJECTS . Barre, J. Y. (CEN de Cadarache, Saint-Paul-les-Durance, France); Laponche, B. Bull. Inform. Sci. Tech. (Paris); No. 168, 7-15(Mar 1972). (In French).

An attempt is made to demonstrate the role of reactor physics in the design of nuclear reactors. The development of reactors involves the coalescence of various disciplines. Experiments are performed that facilitate the development and verification of calculations. Two examples are presented: natural uranium–graphite–gas reactors and the fast neutron reactors studied at Cadarache. (France)

11284 CRITICALITY STUDIES OF A BWR CORE: VARYING HYDROGEN TO METAL RATIO AT DIFFERENT CORE TEMPERATURE AND VOID CONDITIONS. Khan, A. M. (Instituto de Engenharia Nuclear, Rio de Janeiro). J. Inst. Nucl. Eng.; 13: No. 6, 169-73(Nov 1972).

Criticality studies have been performed on a typical BWR core at various temperatures and void conditions, using the LEOPARD Computer Code. Keeping the pin diameter and enrichment fixed at 0.487 in. and 2.2% respectively, the pitch was varied from 0.68 in. to 1.1 in. with core temperatures ranging from room to saturation and 40% voids. In all 49 LEOPARD runs were made, using the material buckling option of the code. The material buckling and critical masses were plotted as a function of hydrogen to metal ratio. The critical mass curves were parabolas (mouth upwards) with minimas. It is noted that as the temperatures were elevated from room to saturated temperatures this minima shifted from a H/M value of 325 to 350. As the voids were introduced this minima shifted backwards to a value of H/M = 300 at 40% voids. The minimum critical mass was found to be 17.5 kg at room temperature. As temperature was raised this minimum value began to increase slowly but registered a rapid increase as voids were introduced in the core. The minimum critical mass at 40% voids was 3.5 kg. It was observed that the rate of increase of minimum critical mass was twice as much if voids were increased from 20% to 40% as for increasing from 0% to 20%. Fast and thermal leakages at different core temperatures and void conditions were also plotted versus hydrogen to metal ratio. The results very interestingly led to the presence of "leakage parabolas" with mouths down. The maxima occurred around a H/M value of 250. Such "leakage parabolas" can be useful in optimizing the blanket design of a thermal breeder. (UK)

11285 EXPERIMENTS AND ANALYSES OF NUCLEAR CHARACTERISTICS OF BURNABLE POISONS. Yamashita, Junichi (Hitachi Ltd., Ibaraki, Japan); Haga, Toru; Oguma, Masaomi. Hitachi Hyoron; 53: No. 11, 1112-15(Nov 1971). (In Japanese).

Criticality of two types of core with several fuel rods containing burnable poison was examined using the Ohzenji critical experiment facility, and was analyzed for the nuclear characteristics of gadolinia, which is contained in the fuel rods for reactivity control and power distribution flattening of BWRs. The effects of burnable poison on reactivity suppression and control rod reactivity, and temperature coefficient of moderator were measured using two types of core at room temperature and with no voids. The change of thermal neutron flux distribution due to the particle size of the poison material was examined in the Hitachi education and training reactor. Results showed excellent nuclear characteristics of the fuel rods with burnable poison, while the analyses proved that calculation techniques currently used can represent the measured values with sufficient accuracy. The experiments showed (1) the effect on reactivity by the rods saturates at a few weight percent concentration of the gadolinia in natural uranium; (2) change in the effect of reactivity due to position in assembly is proportional to thermal neutron flux, when there is no fuel rod with the poison; (3) effect on power distribution by the rods is very local; (4) insertion of control rods lowers the reactivity effect of the nearby fuel rods very much; and (5) the temperature coefficient of the moderator moves to the negative side with increase in number of the fuel rods containing poison. (Japan)

11286 MUTUAL SHIELDING EFFECT IN ^{238}U–^{239}Pu MIXTURE. Kamei, Takanobu; Mizuta, Hiroshi (Nippon Atomic Industry Group Co. Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 312-15(May 1972).

The results are presented of numerical calculations on mutual shielding effects related to the Japanese Prototype Fast Breeder Reactor. The purpose of the calculation is to obtain reliable values for the mutual shielding effects on the cross sections, the multiplication factor, and the Doppler coefficient of a typical fast reactor. The mutual shielding factors are also calculated by the analytical method with σp^{28} and σp^{49} as parameters. The results are compared with those of the numerical calculations for high concentrations of ^{238}U and ^{239}Pu. (auth)

11287 APPARATUS FOR POWER AND BREEDING DISTRIBUTION MEASUREMENTS IN BREEDER REACTORS. Goldstein, Norman P.; Sun, Kuan H. (to Westinghouse Electric Corp.). U. S. Patent DPT901,026. 15 Aug 1972. Filed 12 Nov 1970.

A method and apparatus are presented for determining the power and breeding distribution within a breeder reactor. Detectors comprising small diameter BeO balls are introduced into a series of columnar tubes running longitudinally through various parts of the reactor. After a short period of irradiation, the detectors are sequentially transferred out of the reactor columns to a sodium separator to drain and remove the active sodium surrounding the detectors. Upon exiting the sodium separator, the detectors are conveyed to a parallel arrangement of storage conduits in accordance with the original columnal array formed within the reactor. Once filled, the columns are sequentially emptied past a radiation counter which records the detector readings indicative of the power measurement. The connecting conduits are coupled by valves to return the detectors exiting the counter to the storage columns. This process is repeated until each of the storage columns has been counted. After a specified time for decay, the counting process is repeated to provide a determination of the breeding measurement. Upon exiting the counter, the detectors are routed to their respective initial storage conduits in accordance with the original array formed within the reactor. Storage conduits function as a decay reservoir to enable an adequate period for radioactive decay so that the process may be repeated to supply successive breeding and power determinations. (auth)

11288 COMPACT AND SAFE NUCLEAR REACTOR. Mills, Caroll B.; Brasier, Robert I. (to United States Atomic Energy Commission). U. S. Patent 3,687,804. 29 Aug 1972. Filed 27 Oct 1971.

A compact, lightweight, and low cost nuclear power reactor is described that is safe to build and operate. The reactor core contains the absolute minimum critical mass for the nuclear fuel used and any change in materials or geometry will reduce the reactivity of the assembly. A beryllium reflector surrounds the core and a liquid moderator–coolant circulates through and around it. The device is enclosed in a pressure shell and control is accomplished by state of the art means. The core can be chemically processed and fabricated in one lot and the reactor will not become critical until the core is surrounded by the beryllium reflector and filled with the liquid moderator–coolant. (Official Gazette)

11289 CORE CLAMPING SYSTEM FOR A NUCLEAR REACTOR. Beyer, Frank R. (to North American Rockwell Corp.). U. S. Patent 3,682,774. 8 Aug 1972. Filed 26 Sep 1969.

A core clamping system is designed for fast breeders. It utilizes a cylinder connected to a core support structure of the reactor and which is slotted axially to develop a plurality of cantilever beam–spring segments that act upon the core elements at a determined clamping plane to accommodate for

expansion and contraction of the reactor core and thereby induce a negative contribution to the power coefficient of the nuclear reactor. (Official Gazette)

Control Elements, Systems, and Instrumentation

11290 (HEDL-TME-72-24) TEMPERATURE–VOLTAGE DEPENDENT NOISE IN METAL OXIDE INSULATED CABLES. Stringer, J. L.; Philipp, L. D.; Schemmel, R. R. (Hanford Engineering Development Lab., Richland, Wash.). Jan 1972. Contract AT(45-1)-2170. 29p. Dep. NTIS.

The in-vessel neutron flux monitoring system, being developed for use in the FFTF reactor, encountered both temperature- and voltage-dependent noise generation phenomena when single-ended thermal neutron detectors were tested at temperatures to 900°F. Due to the electrical nature of the noise, it has been generally designated breakdown pulse noise (BPN) by the investigators. Since only metal oxide ceramic (mineral) insulation can be used as cable insulation for prolonged periods at temperatures greater than 500°F and in radiation environments to 10^{21} nvt neutron and 10^{12} R gamma, experiments have been focused on investigations to learn which insulator parameters (density, purity, particle, size, etc.) control the temperature-voltage onset of noise. This study includes ceramic-to-metal and other types of cable and seals, since the metal oxide insulators must remain free of moisture and other contaminants to maintain good performance characteristics. Thus, the high temperature signal cable should always be considered as a hermetically sealed system. Cables with SiO_2 and MgO are being investigated to provide reliable engineering data to designers and suppliers of materials and components for LMFBR application. Tests performed on SiO_2 insulated cables which utilize PYROCERAM insulation in the end seals and some brief tests on MgO insulated cable are described. (auth)

11291 (WASH-1226-30) QUALITY ASSURANCE REQUIREMENTS FOR THE INSTALLATION, INSPECTION, AND TESTING OF INSTRUMENTATION AND ELECTRIC EQUIPMENT. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 11 Aug 1972. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the quality assurance requirements for the installation, inspection, and testing of power reactor electrical equipment and instrumentation. (auth)

11292 P.F.R. STATION CONTROL SYSTEM. Mummery, P. W.; Evans, A. D.; Barclay, F. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Atom (London); No. 193, 197-201(Nov 1972).

A description is given of the control systems and associated instrumentation incorporated in the Prototype Fast Reactor design at UKAEA, Dounreay. In general these are typical of modern power station practice and there are few special problems arising from their application in a liquid metal-cooled fast reactor system. Equipment described includes station computers and steam pressure and temperature controllers, together with miscellaneous equipment. Very few of the instruments are directly exposed to liquid metal, and for those that are, removal for repair of replacement is quite feasible. Overall control of the station should be straightforward. (UK)

11293 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Linning, D. L.; Cowking, C. B. (to United Kingdom Atomic Energy Authority). British Patent 1,279,978. 28 Jun 1972. Filed 20 Dec 1968.

Reference is made to reactor shutdown equipment, particularly for sodium-cooled fast reactors. With conventional arrangements, a severe power excursion may damage or distort the reactor core to an extent that would prevent the control rods being inserted, although in designing a reactor steps are taken to minimize this risk. It has been thought necessary in some cases to provide auxiliary shutdown equipment that operates on entirely different principles, for example, ball shutdown devices. The provision of control and shutdown devices is also made more complicated for reactors having rotatable neutron shields. The object of the system described is to provide additional equipment that will be relatively unaffected by core damage, or by the rotatable shield having been displaced from its normal position while the reactor is on power. The system comprises shutdown absorber elements axially movable in control rod tubes penetrating the reactor core but not the shield, each element normally being located in a part of the tube that extends beyond the core boundary at that end of the core remote from the shield. To shut down the reactor the element is caused to move within the tube in the opposite direction to that of inserting the normal control rods. The operating means preferably takes the form of a spring, with releasable hydraulic holding means for holding the spring in the cocked state. Where the rotatable shield is above the reactor core it is preferable to have arrangements for inserting the shutdown elements upwardly into the core. (UK)

11294 BREEDER REACTOR CONTROL SYSTEMS. Macrae, G. (Westinghouse Electric Corp., Madison, Pa.). Power Eng.; 76: No. 5, 43-6(May 1972).

Control techniques and equipment for both pot-type and pipe-type liquid metal fast breeder reactor systems are discussed. The effects of operating conditions on control techniques are examined. (H.D.R.)

11295 ANTIJAM SLIDING SEAL STRUCTURE. Tschamper, Pierre M. (to United States Atomic Energy Commission). U. S. Patent 3,677,891. 18 Jul 1972. Filed 16 Jun 1971.

The dynamic seals of a reactor control rod are supported by a collapsible seal tube. If the control rod is frozen to the seals, the force exerted on the control rod by the drive motor is sufficient to cause collapse of the seal tube. As the seal tube collapses, the structure supporting the seals is driven against a striking surface. The impact force developed when the seal support structure hits the striking surface is sufficient to break the control rod loose from the dynamic seals. (Official Gazette)

11296 METHOD OF AND APPARATUS FOR CONTROLLING A NUCLEAR REACTOR. Sturmer, Walter; Handel, Hubert (to Hochtemperatur Reaktorbau Gesellschaft mit Beschranter Haftung). British Patent 1,283,881. 2 Aug 1972. Filed 4 May 1971.

Reference is made to control and shutdown arrangements for pebble-bed reactors. Where control rod systems are employed, the rods are run directly with the pebble bed, and are moved to-and-fro for desired variations of power. Through this movement wear occurs on the control rods and fuel elements, and this may result in the passage of fission products into the cooling gas. In the system described one or more tubular jackets, each containing an absorber, are run into the pebble bed, to positions predetermined for the power range to be controlled, and the absorbers are moved in the axial direction inside the jackets by adjusting devices, in accordance with a predetermined control operation. The tubular jackets are seldom moved. The material for the jackets is preferably graphite. Drive mechanisms for the absorbers are described. (UK)

11297 SYSTEM FOR CONTROL OF A BOILING WATER REACTOR AND A BOILING WATER REACTOR FOR APPLICATION OF THE SYSTEM. Rolstad, E. (to Institutt for Atomenergi). Norwegian Patent 123,496. 9 Mar 1972. Filed 1 Apr 1969. (In Norwegian).

In relatively small boiling water power reactors, of 100 MW(e) or less, natural circulation may provide a satisfactory specific power density in the core. A simple and economic control system may then be achieved by varying the void fraction by means of regulation of the coolant flow rate in the fuel channels. This in turn may be regulated by providing the fuel assemblies with risers, formed as extensions of the assemblies' shrouds, and varying the moderator level. Automatic regulation of the moderator level may be achieved by placing the reactor tank in a deep, water-filled well or by connecting a pressurized reservoir to the reactor tank. By having different riser heights the core power distribution may also be optimalized. (Norway)

11298 IMPROVEMENTS IN CONTROL OF NUCLEAR REACTORS. Dale, Walter Bernard (to United Kingdom Atomic Energy Authority). British Patent 1,284,083. 2 Aug 1972. Filed 21 Jan 1969.

In reactors supplying heat to external plant, such as steam or gas turbines, it is sometimes necessary to vary the reactor power, for example, when replacing spent fuel or to suit power demands. Conventional methods of varying reactor power include varying the levels of the neutron flux and the coolant flow values. These methods aim to vary, within limits, the temperatures of the gas outlets from the fuel channels, while at the same time maintaining their distribution across the core substantially unchanged. Changes in neutron flux and coolant flow values can, however, vary the relative temperatures of the fuel and sheath, thereby causing interaction which, in the case of persistent thermal cycling, can result in damage to the sheaths. In the system described the neutron flux levels and coolant flow values relating to different selected regions of the reactor core are varied more or less than the average variation of the levels obtained by considering all the regions together. The regions are selected such that adverse effects of load changing on the fuel charge as a whole are reduced. With this system, it is preferable to strengthen fuel elements of selected group to enable them to resist the adverse

effects caused by change of temperature conditions. Embodiments of the system are described. (UK)

11299 CONTROL ROD SYSTEM FOR A NUCLEAR REACTOR. Mehren, Franz (to Kontrollstabeinheit fuer Kernreaktoren). German Patent 1,299,086. 10 Jul 1969. Filed 30 Nov 1966. (In German).

Purpose of the invention is a simple and reliable mechanism which, during emergency shutdowns of the reactor through central rod insertion, avoids any interference of the insertion motion with the sealing elements. Moreover, the housing containing the driving mechanism for the control rods is removable to allow inspection of the reactor cover. During removal of the housing, absolute reliable sealing is maintained with respect to the reactor gas compartment. The guidance tube for control rods, penetrating the cover and reaching into the reactor core, is described and depicted. (H.B.G.)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

Refer also to abstract 9443.

11300 (WASH-1226-11) INSTRUMENT LINES PENETRATING PRIMARY REACTOR CONTAINMENT. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1972. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the design requirements of primary containment structure instrument line penetrations. (auth)

11301 (WASH-1226-11(Suppl.)) INSTRUMENT LINES PENETRATING PRIMARY REACTOR CONTAINMENT BACKFITTING CONSIDERATIONS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 17 Feb 1972. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the requirements for power reactor containment structure instrument line penetrations. (auth)

11302 (WASH-1226-18) STRUCTURAL ACCEPTANCE TEST FOR CONCRETE PRIMARY REACTOR CONTAINMENTS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 6p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes acceptable test requirements for water-cooled power reactor concrete primary containment structure. (auth)

11303 (WASH-1226-19) NONDESTRUCTIVE EXAMINATION OF PRIMARY CONTAINMENT LINERS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 29 Dec 1971. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes acceptable methods for nondestructive inspection of power reactor concrete primary containment structure liners. (auth)

11304 (WASH-1226-19(Rev.1)) NONDESTRUCTIVE EXAMINATION OF PRIMARY CONTAINMENT LINER WELDS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 11 Aug 1972. 4p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes procedures for the nondestructive inspection of welds in the liners and penetrations of primary reactor containments of concrete construction. (auth)

11305 (WASH-1226-24) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A PRESSURIZED WATER REACTOR RADIOACTIVE GAS STORAGE TANK FAILURE. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 23 Mar 1971. 6p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes acceptable assumptions used in evaluating the radiological consequences of a radioactive gas storage tank failure. (auth)

11306 HIGH TEMPERATURE NUCLEAR REACTORS. Lockett, G. E.; Hosegood, S. B. (to United Kingdom Atomic Energy Authority). British Patent 1,285,248. 16 Aug 1972. Filed 2 Mar 1970.

Reference is made to arrangements for cooling the thermal neutron shield of high-temperature gas-cooled nuclear reactors. It is common practice in such reactors to take a bleed of low-temperature coolant gas and direct it on to the part that is to be cooled, but this adds to the duty of the cooling system and complicates the design of the pressure vessel internals. Moreover it may be expedient to use ceramics or graphite in the core support structure, obviating the need for cooling, an advantage that would be negative if a bleed of coolant were still required to cool the thermal shield. In the system described, a method of thermal shield cooling is provided for reactors whose pressure vessel walls are liquid cooled by forming a heat conductive path between the adjacent face of the shield and the inner faces of the pressure vessel over a substantial area. The thermal shield may be formed of SiN. (UK)

11307 FEASIBILITY OF MEASUREMENT ON COVERINGS ESPECIALLY ON THE LINER OF PRESTRESSED-CONCRETE PRESSURE VESSELS FOR NUCLEAR REACTORS. Magiera, G.; Czaika, N. (Bundesanstalt fuer Materialpruefung, Berlin). Materialpruefung; 14: No. 8, 260-2(1972). (In German).

For the measurement of mechanical properties of coverings it is necessary to have a cavity in the concrete behind the liner for the test data pickup. A description is given of model tests which should indicate the decrease in safety, in particular, the adulterating of measurements which is to be expected by the required dimensions of the cavity. The described elongation tests (elastic elongation, plastic elongation) result in conditions for the reduction of these influences. The experimental arrangement is made to correspond with the conditions of the reactor pressure vessel. (GF)

11308 CONTAINMENTS FOR NUCLEAR REACTORS. Jones, H.; Johnson, F. G.; Ebeling, D. R. (to United Kingdom Atomic Energy Authority). British Patent 1,287,146. 31 Aug 1972. Filed 19 Feb 1969.

Reference is made to containment systems for water-cooled pressure-tube reactors having a refuelling pond above the reactor. It is common practice in such reactors to carry the pond on a sturdy grid structure, through which pressure tube extensions pass, and which is capable of resisting the high loads imposed on it. It is impractical, however, to make a sturdy grid that is readily removable to give access to the reactor, so that, to replace damaged pressure tubes or calandria tubes it is necessary to approach the top of the reactor from below the refuelling pond; because of the complex of pressure tube extensions, replacement of a tube can be a long and costly operation. In the arrangement described, the containment structure is divided by a barrier into a lower chamber housing the reactor and its coolant circuit and an upper chamber housing the refuelling pond. The barrier provides biological shielding and includes a membrane forming the bottom of the pond structure and which is removable to give access to the top of the reactor; the barrier is provided with pressure-relief means for balancing the pressures in the chambers under emergency conditions. In the event of accident, pressure in the lower chamber is relieved into the upper chamber to prevent overpressurization of the reactor containment; the pond bottom is not subject to high stress and can therefore be of relatively light structure so as to be readily removable to gain access to the reactor. The pressure tubes may have extensions that penetrate the membrane and are welded thereto and closed by removable plugs; a flexible bellows arrangement may seal the periphery of the membrane to the barrier to accommodate differential thermal expansion of the extensions and the containment structure. Alternatively the pressure tubes may have vertical extensions that terminate below the membrane, the latter having access apertures closed by valves. Sliding gland seals may also be used to accommodate thermal expansion. Various arrangements of pressure-relief means are described. (UK)

11309 IMPROVEMENTS IN OR RELATING TO PRESSURE VESSELS. Davies, I. L.; Burrow, R. E. D. (to Taylor Woodrow Construction Ltd.). British Patent 1,287,677. 6 Sep 1972. Filed 29 Jul 1970.

Reference is made to pressure vessels for housing liquid metal-cooled nuclear reactors. The pressure vessel described comprises an outer concrete structure enclosing a lined cavity for the hot liquid, with a cooling jacket and heat-conducting material between the jacket and liner. This arrangement serves, under normal operating conditions, to maintain the temperature of the liner within closely controlled limits and that of the outer concrete structure at an acceptable level, and also serves to prevent leakage of liquid from the cavity and the cooling jacket. The conducting material may consist of concrete composed so as to have a conductivity about double that of the outer structure, and loaded with steel shot, stampings, or turnings, or it may consist of mineral aggregate. The cooling jacket may include a number of ducts through which cooling fluid can be passed, and valves may be provided whereby single ducts or groups of ducts can be isolated. (UK)

11310 IMPROVEMENTS IN OR RELATING TO REACTOR PRESSURE VESSELS IN NUCLEAR POWER STATIONS. Scholz,

M.; Wakonig, F. (to Siemens Aktiengesellschaft). British Patent 1,287,712. 6 Sep 1972. Filed 12 Feb 1971.

An arrangement for suspending and supporting pressure vessels in nuclear power stations is described. It is usual for the pressure vessel to be supported by means of a ring, located below the coolant supply and discharge ducts, on the biological shield surrounding the pressure vessel. Safety disadvantages associated with this arrangement are stated. In the arrangement described a structure is provided, capable of supporting the pressure vessel, forming a horizontal partition dividing the reactor chamber into two compartments. The structure has an aperture with dimensions corresponding to the external dimensions of the pressure vessel, and support means are provided below the aperture to cooperate with projections on the pressure vessel, whereby the latter can be suspended from the structure. Means are provided to prevent rotation of the pressure vessel, and the annular clearance between the pressure vessel and the structure is sealed by extensible bellows. Locating plates are provided to allow accurate location of the pressure vessel. The reactor chamber is located in a four-walled reactor building and suspended from three walls of the reactor building by means of tie rods, bearing on the fourth wall and held down by the rods. The structure may be of box-form steel construction and the individual boxes sealed with concrete. (UK)

11311 PROBLEMS ON THE MANAGEMENT OF FILTERS FOR REACTOR USE. 1. AGING AND WEATHERING OF ACTIVATED CHARCOAL USED IN REACTOR CONFINEMENT SYSTEMS. Kitani, Susumu; Ikezawa, Yoshio; Yoshida, Yoshikazu (Japan Atomic Energy Research Inst., Tokai). Kuki Seijo; 8: No. 7, 81-5(Mar 1971). (In Japanese).

Experiments carried out to evaluate various factors contributing to deterioration of activated charcoal used for removal of radioactive iodine and methyl iodide are described. Ascertained characteristics are as follows: (1) As example for aging of filters, there are charcoal filters used only in emergency conditions, but it is expected that impregnated activated charcoal does not deteriorate. Present preservation technique affords 3 to 5 years before removal efficiency is halved. (2) As for weathering of filters used continuously in air exhausting systems, an example is given in which removal efficiency of radioactive iodine after 2 years usage surpasses design value of 99.9%. Nitrogen dioxide existing in the atmosphere is considered as a factor to deteriorate the activated charcoal. (3) High gamma radiation fields produced in the confinement in such accidents as failure of cooling systems enables radiolysis of methyl iodide passing through the filters, which enhances superficial removal efficiency of the impregnated charcoal for methyl iodide. (4) Desorption of impregnated substances is accelerated over 200°C. (5) Loading effects on removal efficiency of the methyl iodide as well as that of elementary iodine is negligible. Remaining problems are as follows. (1) Effects of substances produced radiologically in accident conditions on the impregnated charcoal is unknown. (2) Stability of the impregnated substances under radiation is not studied. (3) Effects of impurities on weathering has to be studied more in detail. (Japan)

11312 METHOD OF AND APPARATUS FOR THE CONDENSATION OF VAPORS FROM A NUCLEAR REACTOR SYSTEM. Henrici, H.; Lehmer, W. (to Linde Aktiengesellschaft). Canadian Patent 901,824. 6 Jun 1972. Priority date 30 Apr 1968, Germany.

A method and apparatus for condensing water vapor or steam to ice in order to prevent the escape of radiation from a nuclear reactor is described. Vapor released from the reactor into an adjacent chamber is condensed on loosely piled masses of ice tubules which are slung in nylon nets to form vapor-permeable stacks. The ice tubules are dried by supercooling prior to introduction into the chamber, and the chamber is refrigerated with a halogenated-hydrocarbon refrigerant. The sytem is claimed to be more efficient and convenient, and to require lesser quantities of ice, than systems previously used. (Canada)

11313 SHIELD PLUG ACCESS ENCLOSURE FOR A NUCLEAR REACTOR. Sutherland, J. D. (to Westinghouse Electric Corp.). U. S. Patent DPT901,028. 15 Aug 1972. Filed 11 Feb 1971.

The shield plug of a liquid metal-cooled fast breeder reactor which uses a hot-cell refueling system has a metal access enclosure sealed to its upper surface. The enclosure contains the control rod drive mechanisms, reactor closure bolts, and other components as are generally mounted on a shield plug, and an air atmosphere is provided within the enclosure. A horizontal extending bellows-like structure allows personnel access to the enclosure from the exterior of the hot cell. (auth)

11314 IMPROVEMENTS IN OR RELATING TO SEALING ARRANGEMENT. Andrews, Edward George David (to Rolls-Royce Ltd.). British Patent 1,282,611. 19 Jul 1972. Filed 25 Oct 1969.

Reference is made in particular to remotely disconnectable sealing members suitable for use in gas-turbine engine power plants having a nuclear reactor as heat source and heat exchangers mounted in a cylindrical pod in the reactor pressure vessel and removable therefrom, the pod having at least two inaccessibly positioned radially extending ducts sealingly connected to further ducts communicating with the reactor and which must be disconnected to permit removal of the pod. A description is given of various alternative designs of such sealing members. (UK)

Cooling Systems

11315 (GEAP-10452) ESTIMATING PIPE RELIABILITY BY THE DISTRIBUTION OF TIME-TO-DAMAGE METHOD. Wilson, S. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar 1972. Contract AT(04-3)-189. 129p. Dep. NTIS.

The "Distribution of Time-to-Damage Method" for reliability estimation is described. The method relies on knowledge of a damage prediction equation, and the uncertainties in the variables appearing in the equation. The uncertainties may be subjective judgments as well as proven or known distributions. For illustration purposes, the method has been used to predict the probability of growing a crack through the wall of a cylindrical pipe in a chosen time period, due to low-cycle fatigue. For this mechanism, the variables of materials, applied stress, and initial crack condition have been considered. (auth)

11316 (WASH-1226-14) REACTOR COOLANT PUMP FLYWHEEL INTEGRITY. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 2p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes integrity requirements of flywheels for water cooled power reactor coolant pump motors. (auth)

11317 (WASH-1226-26) QUALITY GROUP CLASSIFICATIONS AND STANDARDS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 23 Mar 1972. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes a quality classification system for water cooled power reactor cooling systems. (auth)

11318 NUCLEAR REACTOR INSTALLATIONS. (to Sulzer Brothers Ltd.). British Patent 1,285,677. 16 Aug 1972. Filed 2 Jun 1971.

The installation includes a pressure vessel containing a number of pumps for circulating the coolant, each pump being driven by a turbine supplied with coolant as working medium, with the turbines connected in series coolant flow. With such an arrangement, it is possible to distribute the pressure gradient of the working medium over a number of turbines so that they can operate at speeds best suited to their type. The output of the turbines is preferably controlled by a regulating valve in series with them, and in this way it is possible for a series of turbines to be controlled with a single regulating valve. The series connected turbines may be connected in parallel with at least one additional turbine; such an arrangement is particularly suitable where a substantial number of turbines is employed and which, if all connected in series, would produce an insufficient pressure gradient for each turbine. The series-connected turbines may form a closed ring with an additional pump, enabling this pump to be of any desired design and construction irrespective of the design of the reactor feed pumps, and also permitting the circulating pump to be operated independently of the feed. The series of turbines may conveniently be connected to a feed pipe downstream of at least one feed pump and the outlet from the turbines arranged so that at least part of the working medium discharged from the turbines is returned to a pipe upstream of the feed pump. In this way it is possible for the turbine drive to be maintained by the feed pump. If the serially connected turbines have their own driving pump, working medium can be supplied from the feed pipe into the closed ring through the connection downstream of the feed pump, the appropriate quantity of working medium being discharged from the ring into the feed pipe upstream of the feed pump. In this way it is possible to prevent excessive heating of the working medium circulating in the ring circuit. Some alternative arrangements are also described, including the provision of a condensate pump. (UK)

11319 ADJUSTABLE AXIAL FLOW CAVITATION SUPPRESSING FLOW IMPEDANCE. Betts, C.; Collinson, A. E. (to United

Kingdom Atomic Energy Authority). British Patent 1,288,258. 6 Sep 1972. Filed 22 Oct 1969.

Reference is made to liquid-flow control devices and particularly to the problem of cavitation. In nuclear reactors gags may be inserted in coolant flow channels so that pressure drop in the channels can be regulated and coolant flow can be related to heat generation in the channels. Gags of orifice plate-type are usually used, and these give rise to cavitation, especially with large flows and large pressure drops across the gags. This cavitation can set up vibration, that may cause fatigue failures, and also set up noise that interferes with measuring instruments dependent on noise detection. The cavitation-suppressing device comprises a tubular body member, with a series of flow-defining plates transverse to its axis. The plates are arranged alternatively with one set of mesh form so as to define a flow that is cavitation suppressed by virtue of eddy-induced pressure drops developed in downstream spaces, and the second set apertured to define the flow area of the device. (UK)

11320 NUCLEAR REACTORS. Ahmad, S. B. M. (to United Kingdom Atomic Energy Authority). British Patent 1,286,629. 23 Aug 1972. Filed 4 Mar 1969.

Reference is made to coolant circuits of pressurized liquid cooled reactors. In the arrangement described the coolant circuit consists of a number of parallel sections each comprising a circulator feeding arrays of parallel fuel element channels through a distributor, and the sections are interconnected for interchange of coolant flow, the interconnections having fluid flow restriction means. In this way, in a reactor having several parallel coolant circuits or sections, if an interruption in normal flow occurs in one section, a continued supply is assured from adjoining circuits or sections; but where the interruption is due to a breach in a section, then, because of the flow restrictions, flow from the adjoining circuits or sections is substantially restricted, thereby reducing loss of coolant. (UK)

11321 METHOD OF CLEANING PARTS STAINED WITH AN ALKALI METAL. Berrou, F.; Lacroix, A.; Pomie, P. (to Commissariat a l'Energie Atomique). French Patent 2,104,686. 21 Apr 1972. Filed 8 Jul 1970. (In French).

This process enables the efficient cleaning of parts stained by an alkali metal, e.g., parts having remained for some considerable time in the Na bath inside a reactor vessel cooled by circulating Na. The process consists of successively spraying the part with a vaporized water jet (mixture of compressed air and cold water dispersed in fine droplets), a pure water washing jet, and finally a jet of slightly acid water. The device developed is described. Particular emphasis is given to the description of an installation for cleaning an arm for handling fast reactor fuel elements. (France)

11322 PRESSURE TUBE UNITS. Hewins, J. A. (to United Kingdom Atomic Energy Authority). British Patent 1,291,857. 4 Oct 1972. Filed 18 Mar 1969.

Reference is made to units for pressure tube nuclear reactors, such as the steam generating heavy water reactor at UKAEA Winfrith. Where such tubes are arranged vertically the branch pipes conducting the coolant must be stacked, and this increases the height of the reactor. Furthermore, the stacked branch pipes make it difficult to replace damaged pressure tubes, since several such pipes may need to be severed and removed to gain access to a single tube. In the arrangement described the pressure tube unit comprises a number of parallel spaced tubes arranged side-by-side in a row, together with a header pipe transversely penetrated by the pressure tubes. The walls of the pressure tubes within the header pipe are perforated for coolant flow, and bracing plates are provided, one on each side of the header pipe, for bracing the pressure tubes apart. The header pipe is connected to the coolant circuit and serves to conduct coolant from or to each pressure tube, thereby avoiding the need for stacked pipes to each pressure tube. The pressure tube unit is readily replaceable in reactor. (UK)

11323 CASE FOR GAS COOLING. Fortescue, Peter (Gulf General Atomic, San Diego, Calif.). Power Eng.; 76: No. 7, 42-5(Jul 1972).

The principal areas of advantage of gas cooling for both thermal and breeder reactors when compared with water and sodium are briefly discussed. (H.D.R.)

11324 NUCLEAR REACTOR WITH AN INTEGRATED COOLING CIRCUIT. Marmonier, Pierre; Sauvage, Michel (to Commissariat a l'Energie Atomique). French Patent 2,096,939. 3 Mar 1972. Filed 17 Jul 1970. (In French).

A nuclear reactor with an integrated cooling circuit is presented. This reactor possesses a principal vessel filled with liquid coolant (Na) and containing a fuel core, a heat exchanger system, and a pumping system ensuring the circulation of the coolant between the core and the exchanger. The type of reactor suggested is provided with an annular neutron protection ring, which surrounds the core, and a neutron protection envelope which externally doubles the walls of the exchanger. (France)

11325 NUCLEAR REACTORS. Prince, N.; Hibbert, J. (to United Kingdom Atomic Energy Authority). British Patent 1,282,752. 26 Jul 1972. Filed 21 Jan 1969.

Reference is made to reactors of the re-entrant coolant type where coolant flows from an inlet plenum through the core and then reverses to flow through fuel channels in the core to an outlet plenum adjoining the inlet plenum. The arrangement described is directed towards preventing the dividing member separating the inlet plenum from the outlet plenum from failing due to extra pressure that may be put on it as a result of failure elsewhere in the reactor. For this purpose, pressure-relief means are provided in the dividing member; these take the form of rupture disks or pairs of pressure relief valves. Means are also provided to initiate a reactor shutdown signal upon operation of the pressure-relief means. (UK)

Fuel Systems and Components

Refer also to abstract 11505.

11326 (BLG-462) FUEL BED FOR A COATED PARTICLE FUEL ASSEMBLY. Yellowlees, J. M.; Van Asbroeck, P. B. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jan 1972. 41p. (CONF-711215-11). Dep. NTIS (U. S. Sales Only).

From GCFR fuel specialists meeting; Harwell, England (16 Dec 1971).

The GBR Study Group, which was formed in December 1969, considered first of all the design of a 1000 MW(e) gas-cooled fast reactor using fuel pins. Subsequently, the Group studied reactors with layouts similar to that of the pin reactor but using coated particle fuel assemblies. Two different arrangements of assemblies using coated particles are selected. The more important features of these particular assemblies and the associated materials technology are summarized. (66 references) (auth)

11327 (JEN-245) INFORMATION TO BE REQUESTED FROM THE NSSS VENDOR FOR FUEL MANAGEMENT CAPABILITY. Velarde, G.; Aguilar, F.; Ahnert, C.; Aragones, J. M.; Gomez, M.; Guerra, J.; Palmero, A.; Serrano, J. (Junta de Energia Nuclear, Madrid (Spain)). 31 May 1972. 18p. Dep. NTIS (U. S. Sales Only).

A set of the nuclear, thermal-hydraulic, and mechanical parameters necessary to perform the fuel element management and design for PWR's is listed. The data must be supplied by the reactor manufacturer to the utility. (auth)

11328 (UJV-2612-R) THERMAL COMPUTATION OF TUBULAR FUEL ELEMENT INCLUDING MORE ACCURATE CRITERIA FOR DETERMINING FRICTION-INDUCED PRESSURE DROP AND HEAT TRANSFER. PROGRAM MODIFICATIONS. Halouzka, M.; Pecha, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Sep 1971. 49p. (In Czech). INIS.

A program is described for a more accurate computation of a tubular fuel element with longitudinal rectangular fins, designed for a heavy-water CO_2-cooled reactor. The program includes modified dimensionless criteria for determining the friction coefficient and the Nusselt number in non-annular channels with hydraulically smooth walls. The results are also given of a computation of a double-tube fuel element, yielding much lower values of friction and heat transfer coefficients if the modified dimensionless criteria are applied; this has an adverse effect upon the fuel element proposed. (INIS)

11329 (WCAP-7908) FACTRAN: A FORTRAN IV CODE FOR THERMAL TRANSIENTS IN A UO_2 FUEL ROD. Hargrove, H. G. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Jul 1972. 15p.

FACTRAN calculates the transient temperature distribution in a cross-section of a metal-clad UO_2 fuel rod and the heat flux at the surface of the cladding, using as input the nuclear power and the local conditions of the coolant (pressure, flow, temperature). All those conditions may be functions of time. (auth)

11330 NUCLEAR FUEL PINS. Cayol, A.; Clottes, G.; Ratier, J.-L. (to Commissariat a l'Energie Atomique). French Patent 2,104,669. 21 Apr 1972. Filed 19 Jun 1970. (In French).

This fuel pin for a fast reactor consists of a can closed by plugs

which contains a column of fissile fuel pellets. The pin is provided with a wire which is spirally wound around the can and attached to the two plugs at its ends. The cross section of the part of the can containing the fissile material is constant and slightly less than the cross section at the plug ends. The pin also contains a column of pellets composed of fertile material. The part of the can containing the fertile material forms together with the plug and end part of the pin. (France)

11331 FUEL ELEMENT FOR NUCLEAR REACTOR. Gauthron, M.; Seguin, M. (to Commissariat a l'Energie Atomique). French Patent 2,104,678. 21 Apr 1972. Filed 3 Jul 1970. (In French).

This fuel element consists of a hollow fuel cylinder provided with an inner and an outer casing. The fuel cylinder is also provided with a radial slit extending over the entire height of the cylinder. The elasticity of this slit maintains it against one of the casings. The fuel cylinder may be in contact with the internal surface of the outer casing. The radial slit of the fuel cylinder lies between 0.2 and 1 mm wide. (France)

11332 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Hyne, M. G.; Simpkin, S. D. (to British Nuclear Design and Construction Ltd.). British Patent 1,279,242. 28 Jun 1972. Filed 13 Aug 1968.

The fuel element assembly described comprises a number of layers of rod-like fuel pins, held in spaced relationship in a coolant channel and supported by the channel wall. Support grids are located between the layers of fuel pins, provided with ribs engaging the channel walls to center the grids. Each support grid may be provided with projections on its upper and lower faces, providing axially offset seating and bearing surfaces for the adjacent ends of two layers of pins, the arrangement being such that the weight of the upper layer of pins acts through the support grid to urge the adjacent ends of the layers laterally towards the wall of the coolant channel. Where the assembly is to be used in reactor core columns formed from individual bricks, at least one layer of fuel pins may be supported in that part of the coolant channel extending through each brick, the support comprising an annular seating provided by a change in diameter of the channel adjacent to the lower end of the brick. (UK)

11333 NUCLEAR REACTOR FUELLING INSTALLATIONS. Paget, F. T. W.; Critchley, J. (to United Kingdom Atomic Energy Authority). British Patent 1,288,073. 6 Sep 1972. Filed 19 Mar 1969.

The object is to provide for a water-cooled reactor and a containment structure that simplifies the refuelling procedure and thereby reduces the period of shutdown required for such operations. The arrangement is intended for reactors having vertical fuel channels and a pond of water above the reactor into which fuel assemblies can be withdrawn. A fuel exchange chamber is provided connectable with the pond by a sealable duct for flooding the chamber and for passage of fuel assemblies. This chamber and the containment structure have a common closable access duct for passage of fuel assemblies between the chamber and the outside of the containment structure. The pond extends horizontally beyond the reactor and the fuel exchange chamber is located beneath the pond extension. The common access duct is located horizontally to communicate with the pond outside the containment structure and the chamber contains manipulating equipment for receiving and discharging fuel assemblies through the duct, this equipment being capable of pivoting the assemblies between vertically and horizontally aligned positions. Vertically aligned assemblies can be transported between the reactor and fuel exchange chamber while submerged in water, with little difficulty, so that the reactor can be refuelled and returned to full power quickly, and complex manipulations of the assemblies can be carried out in the chamber after the reactor has been returned to full power. (UK)

11334 IMPROVEMENTS IN NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Tutte, E.; Butterfield, C. E. (to United Kingdom Atomic Energy Authority). British Patent 1,286,144. 23 Aug 1972. Filed 5 Feb 1969.

Reference is made to fuel element assemblies in the form of stringers that are inserted into the reactor core as a single body, and particularly to stringers having fuel elements in the form of clusters of fuel rods supported in structural sleeves. The fuel elements of such stringers are supported during charging and discharging by tie rods; the use of tie rods, however, has several disadvantages. The object of the arrangement described is to provide a stringer design that overcomes these disadvantages. The fuel elements are carried by openwork structures external to the fuel element sleeves; these structures may be formed by longitudinal runs of wire wound in helical fashion. At least one fuel element may be connected to an upper part of the stringer by a screwed sleeve having a skirt portion that embraces the sleeve of the fuel element, with a small clearance to provide a restriction to choke the ingress of coolant in the event of a substantial gap occurring between the sleeve and this upper part while the reactor is in service. (UK)

11335 IMPROVEMENTS IN AND RELATING TO DEVICES FOR SENSING THE RELATIVE LOCATION OF TWO NUCLEAR FUEL ELEMENTS. Cooke, B. F. (to Nuclear Power Group Ltd.). British Patent 1,279,875. 28 Jun 1972. Filed 9 Dec 1969.

When inserting fuel elements into the fuel channels of a reactor core using a charge machine, it is important to ensure that each element seats correctly on the element below. The method described for sensing the relative location of two fuel elements comprises means for supplying a flow of fluid through the grab of the charging machine to a passage in one of the fuel elements, whereby when the two bodies are located correctly with respect to one another the flow of fluid is interrupted; means are provided for sensing the interruption. The foregoing passage may communicate with a further passage in a projection on the lower face of the fuel element, this projection entering a recess on the upper face of the next fuel element below; in this arrangement the fluid flow is interrupted only when the projection is correctly located in the corresponding recess. (UK)

11336 FUEL ELEMENT OF A NUCLEAR REACTOR. Hafner, O.; Stracke, W.; Zimmermann, M. (to Brown, Boveri and Co., Ltd.). German Patent 2,054,394. 20 Apr 1972. (In German).

The claims are concerned with the fuel element of a graphite-moderated gas-cooled homogeneous reactor where the fuel is encased in an ingot-mold moderator which contains boreholes for the streaming gas coolant. The fuel is encased in cells which are ordered in orientation in boreholes and loosely inserted. Moreover a description is given of a device for the displacement of the fuel from the moderator block. (GF)

11337 FUEL ASSEMBLY FOR INSERTION FROM ABOVE INTO A NUCLEAR REACTOR CORE. Suvanto, A. van Santen, A. (to Allmanna Svenska Elektriska Aktiebolaget). U. S. Patent 3,697,375. 10 Oct 1972. Priority date 2 Dec 1968, Sweden.

In a fuel assembly for insertion from above into a (BWR) core a fuel rod bundle is arranged as a freely removable loose insert in a weight-carrying square sheathing tube, which has at its upper end connection members such as two diametrically opposed lifting lugs permitting a grab member in a lifting device to grab the sheathing tube for lifting the entire fuel assembly. The upper part of the sheathing tube is formed as springs supporting the fuel assembly laterally against an upper core grid and supporting the fuel rod bundle laterally against the sheathing tube wall. 10 figures. (Official Gazette)

11338 NUCLEAR FUEL ASSEMBLY WITH FLOW CHANNEL RESTRAINING MEANS. Mefford, C. R.; Lass, J. L.; Smith, B. A.; Venier, D. A.; Trocki, T. (to General Electric Co.). U. S. Patent 3,697,376. 10 Oct 1972. Filed 15 Aug 1969.

A nuclear fuel assembly is designed incorporating a restraining arrangement for engaging the flow channel and limiting its deflection away from the lower tie plate to control the bypass flow of coolant into the spaces between the fuel assemblies of a nuclear reactor. (6 figures.) (Official Gazette)

11339 IMPROVEMENTS IN AND RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Robinson, J. A. (to Nuclear Power Group Ltd.). British Patent 1,292,335. 11 Oct 1972. Filed 23 Apr 1969.

Reference is made to fuel elements for high temperature reactors, in which the fuel member is enclosed in a graphite container. In operation the fuel member shrinks by a greater amount than the graphite container and gaps open up, causing local overheating of the fuel and disturbance of the heat transfer. In the fuel element described adjacent surfaces of the container and fuel member are provided with fins, those on the container overlapping radially those on the fuel member. Initially the fuel member is a close fit inside the graphite container and the radial height of the fins is such that an overlap is maintained even after the gap that occurs during operation has reached a maximum value. (UK)

11340 FUEL ASSEMBLY FOR A LIQUID-METAL-COOLED FAST BREEDER REACTOR. Huebotter, Paul R.; Bump, Thomas R. (to United States Atomic Energy Commission). U. S. Patent 3,677,893. 18 Jul 1972. Filed 29 Oct 1971.

A fuel assembly for a liquid-metal-cooled fast breeder reactor includes a bundle of stainless-steel-clad fuel pins enclosed within a stainless-steel coolant duct with a flow separator being disposed

in the annulus between the bundle of fuel pins and the coolant duct. The flow separator is spaced away from the coolant duct to provide a coolant channel adjacent to the coolant duct and includes an inner and an outer wall enclosing a chamber filled with liquid-metal coolant. Imperforate springs extending across the chamber between the inner and outer wall yield when the fuel bundle swells and prevent vertical flow of coolant within the chamber. Flow vents are provided in the outer panel to equalize pressure between the interior of the flow separator and the coolant channel and evacuated insulating spaces containing a single layer of screen wire each are provided in the inner wall of the flow separator. (Official Gazette)

11341 BIMETALLIC SPACER GRID. Gaines, Albert L. (to Combustion Engineering, Inc.). U. S. Patent 3,686,071. 22 Aug 1972. Filed 19 Aug 1969.

A bimetallic spacer grid for fuel element support in reactors is described. A plurality of spacer elements formed from a first material having characteristic low neutron capture cross section are mated with spring ferrules formed of a second material having better stress relaxation properties than the first material so as not to suffer substantial decrease in resiliency due to prolonged exposure to intensive radiation. The spring ferrules are interconnected in a separate matrix so as to always be retained within the spacer grid arrangement. (Official Gazette)

11342 NUCLEAR FUEL ASSEMBLY WITH LEAKAGE FLOW CONTROL MEMBER. Smith, Bart A.; Lass, James L.; Venier, Dominic A. (to General Electric Co.). U. S. Patent 3,689,358. 5 Sep 1972. Filed 15 Aug 1969.

A BWR fuel assembly is designed which incorporates a leakage flow control member between the flow channel and the lower tie plate to control the bypass flow of coolant into the spaces between the fuel assemblies. (Official Gazette)

11343 FUEL ELEMENT FOR GAS REACTORS. Ropers, Johann (to Siemens AG). German Patent 1,514,489. 25 Jun 1970. Filed 30 Jun 1965. (In German).

The fuel element for gas-cooled nuclear reactors consists of a number of fuel rods which are positioned by an upper and lower plate. The fuel rod bundle is surrounded by an external guidance tube of graphite which is connected to the positioning plates of the rods. Positioning plates and guidance tube are held together by axial bolts which are radially anchored at the outside of the guidance tube. The anchorage can be accomplished with swallow-tail metal pieces. The bolts can be fastened by screwing, riveting, and by elastic spring connections. (H.B.G.)

11344 NUCLEAR REACTORS FUEL ASSEMBLY. Bairiot, H. (to Societe Belgonucleaire, SA). Belgium Patent 714,952. 10 May 1968. (In French).

The goal of this invention is to replace conventional support bars by new ones that carry nuclear fuel throughout the entire height of the reactor core. This can be realized by manufacturing the connecting pieces in such a way that they can be filled with fuel through vibration. A fuel assembly is described for boiling water reactors in which the fuel rods are kept in position by means of a spacement grill. The grill is attached to at least one of the fuel rods that is filled with fuel granules which are homogeneously vibrated in the interior of the reinforcement pieces provided for attachment to the grill. The reinforcement piece can either have a conical interior boring or an annular form. The assembly is described and depicted. (H.B.G.)

11345 FUEL ELEMENTS FOR FLUID-COOLED NUCLEAR REACTORS. Joyce, Alfred John; Maccabee, Alan Roy (to British Nuclear Design and Construction Ltd.). British Patent 1,281,878. 19 Jul 1972. Filed 11 Oct 1968.

The fuel element described has one or more fuel pins, each pin comprising coated fuel particles, containing ^{238}U, contained within a sealed SiC tube. A central core of moderator material, e.g., graphite, is provided within the sealed tube, with the fuel particles contained in the annular space between the core and the tube walls. In this way the statistical behaviour of neutrons is modified so that the rate of conversion of ^{238}U into ^{239}Pu is increased, and can be adjusted to any desired value within a wide range by suitable choice of tube, fuel, coating, and core dimensions. A further advantage is that the fuel may be operated at higher heat ratings as a result of the geometrical change introduced by incorporation of the graphite core. (UK)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

11346 (WASH-1226-1) NET POSITIVE SUCTION HEAD FOR EMERGENCY CORE COOLING AND CONTAINMENT HEAT REMOVAL SYSTEM PUMPS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 2 Nov 1970. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes a suitable relationship between increases in containment pressure caused by postulated loss of coolant accidents and the net positive suction head of emergency core cooling and containment heat removal system pumps. (auth)

11347 (WASH-1226-6) INDEPENDENCE BETWEEN REDUNDANT STANDBY (ONSITE) POWER SOURCES AND BETWEEN THEIR DISTRIBUTION SYSTEMS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 2p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes an acceptable degree of independence between redundant standby (onsite) power sources and between their distribution systems. (auth)

11348 (WASH-1226-9) SELECTION OF DIESEL GENERATOR SET CAPACITY FOR STANDBY POWER SUPPLIES. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes an acceptable basis for the selection of diesel generator set of sufficient capacity to satisfy reactor onsite standby power requirements. (auth)

11349 (WASH-1226-13) FUEL STORAGE FACILITY DESIGN BASIS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 3p. Dep. DRS, USAEC Washington, D. C.

A safety guide is presented which describes the design basis requirements for the fuel storage and handling systems for power reactors. (auth)

11350 (WASH-1226-22) PERIODIC TESTING OF PROTECTION SYSTEM ACTUATION FUNCTIONS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 17 Feb 1972. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes acceptable periodic test requirements for power reactor protection system activation functions. (auth)

11351 (WASH-1226-25) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A FUEL HANDLING ACCIDENT IN THE FUEL HANDLING AND STORAGE FACILITY FOR BOILING AND PRESSURIZED WATER REACTORS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 23 Mar 1972. 10p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which gives acceptable assumptions to be used in evaluating the potential radiological consequences of a fuel handling accident in the fuel handling and storage facility of boiling and pressurized water reactors. (auth)

11352 (WASH-1226-27) ULTIMATE HEAT SINK. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 23 Mar 1972. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the requirements of reserve cooling water sources for water cooled power reactors. (auth)

11353 (WASH-1226-32) USE OF IEEE STD 308-1971, "CRITERIA FOR CLASS IE ELECTRIC SYSTEMS FOR NUCLEAR POWER GENERATING STATIONS". Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 11 Aug 1972. 2p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the requirements for electric power supply systems for power reactors. (auth)

11354 NUCLEAR REACTOR WITH FUEL ELEMENTS POURED INTO THE FISSION ZONE. Haefele, Wolf (to Gesellschaft fuer Kernforschung mbH). German Patent 1,464,740. 18 Sep 1969. Filed 13 Nov 1962. (In German).

Into the nuclear reactor, consisting of external containing walls, are poured spherical fuel elements. The pouring is guided through the fission zone by at least one separating wall which is arranged perpendicular to the containing wall and proceeds helically along the vertical axis. The cooling medium is conducted through a central space which runs parallel to the helix axis. The helical guidance system is outlined in its application to four reactor designs. (H.B.G.)

11355 CHARGE/DISCHARGE ARRANGEMENTS FOR NUCLEAR REACTORS. Pugh, J. (to United Kingdom Atomic Energy Authority). British Patent 1,286,153. 23 Aug 1972. Filed 3 Apr 1969.

An arrangement is described for replacing reactor core compo-

nents such as fuelled moderator blocks, that comprises a guide tube introducible into a penetration in the reactor vessel wall and communicating with an exterior charging device. The mounting means for the tube is arranged so that the tube is adjustable relative to the penetration by means of a cranked arm with one end rotatably mounted in an eccentric located within the tube, the cranked arm being rotatable on an axis parallel to the tube axis. The other end of the cranked arm extends from the tube and carries core component gripping means and means for adjusting the rotational axis of the arm relative to that of the guide tube by rotating the eccentric. (UK)

11356 DETECTION OF BURST SLUGS. Donguy, R.; Graftieaux, J. (to Commissariat a l'Energie Atomique). French Patent 2,104,715. 21 Apr 1972. Filed 24 Aug 1970. (In French).

A technique for detecting burst slugs is presented. Successive samples of the gas emitted by a reactor are taken. Each of the samples is passed into a chamber in which an electric field precipitates the radioactive ions on a movable disk which forms part of the wall of the chamber. This disk is moved into a position beneath a β detector. The γ ray emission of this disk or other collection disks is examined with an energy-discriminating installation. (France)

11357 LOCALIZATION OF BURST SLUGS. Delisle, J.-P.; Pochard, R.; Porte, R.; Prouteau, L. (to Commissariat l'Energie Atomique). French Patent 2,105,071. 28 Apr 1972. Filed 22 Sep 1970. (In French).

A procedure was developed for localizing burst slugs in nuclear reactors cooled by ascending Na. A gas at a pressure slightly in excess of that of the liquid at the outlet of the assemblies is injected into these outlets in order to produce an emulsion. This emulsion is collected. The gas is then separated and analyzed in order to detect the presence of radioactive products. (France)

11358 CHARGE/DISCHARGE ARRANGEMENTS FOR FLUID-COOLED NUCLEAR REACTORS. Williams, M. R. L.; Dobson, D. E. (to British Nuclear Design and Construction Ltd.). British Patent 1,279,603. 28 Jun 1972. Filed 11 Sep 1968.

The system described has particular application to a reactor of the kind in which the core is built up from vertical columns, with fuel channels, these columns being withdrawable through a standpipe at one end of the pressure vessel. The arrangement includes tube means adapted to be inserted at the other end of the pressure vessel via a second standpipe, together with a fixed tube extending between the second standpipe and the corresponding end of the selected column and adapted to located in axial alignment against this end. This fixed tube has an aperture through which coolant normally flows for passage through the fuel channels in the column, and means are provided for moving the tube in either axial direction with respect to the core to facilitate removal and replacement of the column through the pressure vessel. Valve means are provided in the wall of the tube, extending longitudinally, so that during axial movement of the tube the pressure of coolant causes local opening of the valve as the tube passes the aperture in the fixed tube, allowing coolant to flow through the tube into the fuel channels; the remaining portion of the valve means remains closed, due to the pressure of the coolant in the tube, thereby preventing coolant from escaping into the void left in the core during removal and replacement of the selected column. The valve means may comprise a number of flap valves. The tube means forms part of a machine that is positioned below the pressure vessel and is raised with respect to the core to remove the selected columns or lowered for replacement of the column. A second machine may be positioned above the pressure vessel, having a guide tube for receiving the selected column and means whereby the guide tube can be inserted into or removed from the end of the pressure vessel, via the first standpipe, and can be aligned over the selected column; the guide tube has a latching device whereby the column may be latched within it prior to withdrawal from the pressure vessel. The means for moving the tube in either axial direction may comprise a two-stage chain elevator. (UK)

11359 IMPROVEMENTS IN NUCLEAR REACTORS. Birts, L.; Challender, R. S. (to United Kingdom Atomic Energy Authority). British Patent 1,291,706. 4 Oct 1972. Filed 16 Jan 1969.

Reference is made to arrangements for removal of heat from a reactor core under emergency conditions, such as a leak in the primary coolant circuit. The arrangement described has particular application to reactors of the integral PWR type, but can be applied to any reactor coolant system where a significant pressure drop occurs from normal operating pressure when subjected to a temperature reduction. The system provides a means for rapidly depressurizing a reactor that has sustained a leak, so that low power pumps can be employed to replenish the coolant before its level has fallen to a point at which there is a danger of the core melting. The arrangement also provides a means for disposal of shut-down heat. The system functions in two stages, using an emergency water supply. In the first stage the emergency water is fed through the boiler so that the normal coolant has its temperature and pressure lowered by heat exchange in the boiler; in the second stage the emergency water supply functions as a reservoir from which the normal coolant is replenished. The water provided for reactor shielding purposes can be used for the emergency supply. The low power pumps can be energized from storage batteries. (UK)

11360 LOADING DEVICE FOR FUEL ELEMENTS AND CONTROL RODS IN A NUCLEAR REACTOR. Krueger, Joachim; Schabert, Hans-Peter; Schubert, Franz; Weber, Robert (to Siemens AG). U. S. Patent 3,691,011. 12 Sep 1972. Filed 30 Oct 1968.

The loading device includes a vertically travelling double manipulator having respectively an independently actuable control rod manipulator and fuel element manipulator. (Official Gazette)

11361 CHARGE/DISCHARGE ARRANGEMENTS FOR NUCLEAR REACTORS. Pugh, John (to United Kingdom Atomic Energy Authority). British Patent 1,282,722. 26 Jul 1972. Filed 9 Jan 1969.

A gas-cooled reactor construction is described having a core made up with a number of columns of superimposed blocks of moderator-bearing nuclear fuel. The columns have clearance on some of their adjacent flanks, but are held in partial interlocking relationship by unfuelled withdrawable longitudinal plugs that urge blocks adjacent to the plugs so as to fix the clearances while the core is operative. By removal of a plug by a charge machine, prior to block replacement, slackness is created between the blocks in the vicinity of the plug, thus facilitating refuelling. The charge machine, which may be adapted for on-load refuelling, comprises a small mobile pressure container maneuverable over the top of the pressure vessel standpipes, and houses the necessary plug removal and fuel block removal tools; these tools are described. Various alternative arrangements of the system are also described. (UK)

Operation and Economics

11362 (NP-19598) THIRTEENTH ANNUAL REPORT, 1971-1972. OECD High Temperature Reactor Project: DRAGON. (European Nuclear Energy Agency, Paris (France)). 156p. Dep. NTIS (U. S. Sales Only).

Activities of the Dragon Reactor project for the period from April 1, 1971 to March 31, 1972 are reported. Summaries are included for reactor operation, materials development, reactor technology, technical services, and administration. (H.D.R.)

11363 (WASH-1226-16) REPORTING OF OPERATING INFORMATION. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 13p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the reporting requirements for power reactor operation. (auth)

11364 (WB-KE-2020) STEAM STORAGE AS AN ECONOMIC MEANS OF LOAD PEAKING WITH NUCLEAR POWER PLANTS. Beckmann, G.; Fritz, K.; Gilli, P. V.; Lippitsch, J. (Waagner-Biro A. G., Vienna (Austria)). Sep 1971. 20p. (In German). INIS.

For the most promising flow sheet, detailed design studies are performed and optimized for minimum power cost. They are based on a peak load to be carried by the storage plant of 400 MW electrical output which may be an appropriate size for today's standard nuclear base load plant sizes of 1200 MW(e), which has been selected to be the output of the main turbine of the plant. The investigations yielded a cost optimum at 20 atm main accumulator pressure and at 40 atm superheat accumulator pressure, and they confirmed the cost estimates of the storage plant. Only the use of superheated steam made possible the utilization of the optimum accumulator pressure by keeping steam wetness at turbine exhaust within acceptable limits; it furthermore leads to a marked improvement of turbine efficiency and storage efficiency. (auth)

11365 FUNDAMENTAL ECONOMIC AND NATIONAL ENERGY BALANCE CONSIDERATIONS UNDERLYING THE FUTURE DEVELOPMENT OF THE NUCLEAR POWER INDUSTRY IN POLAND. Fiszer, Waclaw (Ministry of Mining and Power, Warsaw). Nukleonika; 16: No. 9-10, 485-92(1971).

The up-to-date state of the Polish electric power system, its

anticipated development up to 2000, and the national coal resources are presented. There are also discussed the general premises for the balance of power resources in Poland affecting the development rate of the nuclear electric power industry and economic conditions of nuclear power industries as well as the anticipated type of the first nuclear power stations in Poland. (auth)

11366 OPTIMUM SEEKING METHODS APPLIED TO NUCLEAR REACTOR DESIGN. CASE STUDY OF MINIMIZING FUEL AND HEAVY WATER COSTS. Suda, Nobuhide (Osaka Univ.); Ogo, Kiyoshi. Nippon Genshiryoku Gakkaishi; 14: No. 8, 422-9(Aug 1972). (In Japanese).

In designing nuclear reactors there are some independent variables the values of which can be selected by the designer. The power generation cost, for example depends upon the values of these design parameters and, hence, optimization has to be carried out to find out the value of the parameters for which the cost is minimum. This type of problem has been solved by the designers relying on their engineering judgement. Recent developments in systems engineering would appear to afford a more sophisticated approach to the problem. Optimization methods are applied to a problem of this kind; the heavy water moderated, boiling light water cooled reactor has been selected as an example. The cost is too complicated to be described in a closed form and, therefore, analytical methods of optimization are difficult to use. Two typical direct search methods, namely the pattern search method and the simplex method, are applied. Both methods have proved to give reasonably good results. But the cost factor in this problem is multi-modal, and hence sometimes only a local optimum is obtained instead of the global, and a point very close to the optimum is easily discovered, but much computation is required to ascertain that this point is close to a local optimum. It is concluded that these methods are useful for optimizing the reactor design in the stage of "parametric survey", and that if effective ways are developed to find the global optimum and to ascertain that a point is close to the optimum, then these methods can become even more useful. 11 references. (auth)

11367 FUEL AND ENERGY RESOURCES, 1972. PART I. HEARINGS BEFORE THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, HOUSE OF REPRESENTATIVES, NINETY-SECOND CONGRESS, SECOND SESSION, HEARINGS HELD IN WASHINGTON, DC, APRIL 10, 11, 12, AND 13, 1972. Serial No. 92-42. Washington, DC; Joint Committee on Atomic Energy (1972). 453p. GPO $1.75.

The fuel and energy situation in the U. S. is examined for the period up to 1985. The discussions are limited to questions of supply and demand. (H.D.R.)

11368 FUEL AND ENERGY RESOURCES, 1972. PART II. HEARINGS BEFORE THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, HOUSE OF REPRESENTATIVES, NINETY-SECOND CONGRESS, SECOND SESSION, HEARINGS HELD IN WASHINGTON, DC, APRIL 14, 17, 18, AND 19, 1972. Serial No. 92-42. Washington, DC; Joint Committee on Atomic Energy (1972). 504p. GPO $2.00.

Safety and Siting

11369 (AEC-tr-7361) INVESTIGATION OF THE PROCESSES IN PRESSURE RELIEF OF WATER COOLED REACTORS EXPERIMENTS WITH THE 11.2 M VESSEL WITHOUT INCORPORATED STRUCTURES. VOL. I. EIGHTH REPORT FOR THE FEDERAL MINISTRY FOR EDUCATION AND SCIENCE; FINAL REPORT ON RESEARCH PROJECT RS 16, JULY 1971. Kanzleiter, T.; Kahn, J.; Saeuberlich, C.; Stein, K.; Zimmermann, M. Translated by W. J. Grimes from a German report. 98p. Dep. NTIS.

The fracture of a main conduit directly at the pressure vessel of a boiling water reactor and a pressurized water reactor were studied with a steel vessel 11.2 m in effective height and 0.8 m in diameter. In the boiling water reactor experiments, at an initial pressure of 70 atm and with correlated saturation temperature of 285°C, the factors varied were: initial water level; temperature layering of the vessel contents; inlet edge to the fracture cross section (sharp or rounded); and fracture cross section. In the pressurized water reactor experiments, with an initial vessel pressure of 140 atm, a saturation pressure of 77 atm was established in the region of the outflow cross section. Temperature distribution along the axis of the vessel was varied. In the boiling water reactor and pressurized water reactor experiments, the time variation of the following magnitudes was determined: static pressure at several places in the vessel and in the outflow pipe; temperature at various levels in the reactor and in the outflow pipe; horizontal reaction force at the level of the outflow pipe; and instantaneous outflowing quantity. (auth)

11370 (AEC-tr-7385) REPORTS CONCERNING THE RESEARCH PROJECTS IN THE FIELD OF REACTOR SAFETY SUPPORTED BY THE FEDERAL MINISTRY OF EDUCATION AND SCIENCE. Research Reports for the Period 1 January-31 March 1972. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). Translated from report IRS-F-10. 87p. Dep. NTIS.

Short administrative summaries of the various projects related to reactor safety in the Federal Republic of Germany are presented. Project accountability information is included. (J.M.J.)

11371 (BAW-10041) FUEL ASSEMBLY STRESS ANALYSIS FOR SEISMIC EXCITATION AND LOSS-OF-COOLANT ACCIDENT FOR B AND W's NOZZLE-SUPPORTED VESSEL. Dideon, C. G. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Nov 1972. 61p.

The Babcock & Wilcox fuel assembly is used with three different sized reactor vessels which are supported at their nozzle level. The capability of the fuel assemblies to withstand seismic excitation and/or a loss-of-coolant accident (LOCA) is evaluated for nozzle-supported vessel designs. The fuel assemblies are analyzed for an operational base earthquake (OBE) and a safe shutdown accident (SSA) which is safe shutdown earthquake (SSE), LOCA, and/or a combined SSE and LOCA. The analysis demonstrates that the fuel assemblies can withstand these conditions without exceeding allowable limits. The method of analysis for the fuel assemblies under accident conditions and a base for determining the design margin of individual nuclear steam systems are presented. (auth)

11372 (BAW-10051(Rev.1)) DESIGN OF REACTOR INTERNALS AND INCORE INSTRUMENT NOZZLES FOR FLOW-INDUCED VIBRATION. Hooker, E. O. (Babcock and Wilcox Co., Lynchburg, Va. (USA). Nuclear Power Generation Div.). Nov 1972. 8p.

The redesigned reactor internals and incore instrument nozzles were analyzed for operational, flow-induced loadings. The results of the analyses show that the reactor internals and incore instrument nozzles are structurally adequate for long-term operation. (5 references) (auth)

11373 (COO-2152-5) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report for the Period Ending September 30, 1972. (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). [nd]. Contract AT(11-1)-2152. 10p. Dep. NTIS.

Preparations for transient pressure drop and transition boiling and reflooding heat transfer experiments are described. Results of two-phase pressure drop and flow pattern measurements are reported. (H.D.R.)

11374 (HEDL-TME-72-126) VOID DISTRIBUTION CONSIDERATIONS FOR WET CORE LMFBR DISASSEMBLY CALCULATIONS. Waltar, A. E.; O'Dell, L. D. (Hanford Engineering Development Lab., Richland, Wash.). Sep 1972. Contract AT-(45-1)-2170. 29p. Dep. NTIS.

In studies of LMFBR hypothetical overpower transients, it is possible to postulate conditions which will ultimately lead to hydrodynamic core disassembly. Correct modeling of the void distribution in wet regions of the core then becomes quite important since early pressure, and subsequent early nuclear shutdown, can be accomplished once the void space is filled by expanding fuel. Results of a previous study, based on a core model containing a spatially uniform void distribution, imply that the calculated energy release is strongly sensitive to the introduction of only a few percent void in the normally wet regions of the core. The purpose of the present study is to determine whether such conclusions are valid if more realistically attainable void distributions are modeled. Using the MELT-II/VENUS computational system to investigate the dynamic behavior of the FFTF, a core disassembly condition was calculated to occur at a time when the inner two subassembly rows were essentially voided of sodium (approximately 2.5 v/o lumped core void) and the reactivity ramp rate was approximately 150 $/sec. Using this condition as a base, parametric calculations were performed for the introduction of uniform voids into the remaining sodium and for large lumped voids in either of the two driver fuel zones. (8 references) (auth)

11375 (ORNL-TM-3973) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR JULY-AUGUST 1972. Cottrell, W. B. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 167p. Dep. NTIS.

The accomplishments during the months of July and August in the research and development program are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects

current safety problems, such as blowdown heat transfer studies. Other major projects include experimental investigations of the attachment of nozzles to shells and the implementation of joint AEC–PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and the liquid-metal fast breeder reactor (LMFBR) programs. Seismic considerations of particular significance in nuclear plant design are evaluated in the seismic program. Several of the above projects are also directly related to another major undertaking, the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the emphasis on environmental effects. (auth)

11376 (WASH–1226-2) THERMAL SHOCK TO REACTOR PRESSURE VESSELS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 2 Nov 1970. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which provides criteria to assure that the reactor pressure vessel will be nonbrittle during coolant loss accident conditions in water cooled power reactors. (auth)

11377 (WASH–1226-3) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A LOSS OF COOLANT ACCIDENT FOR BOILING WATER REACTORS Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 2 Nov 1970. 13p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which gives acceptable assumptions that may be used in evaluating the radiological consequences of a loss of coolant accident for a boiling water reactor. (auth)

11378 (WASH–1226-4) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A LOSS OF COOLANT ACCIDENT FOR PRESSURIZED WATER REACTORS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 2 Nov 1970. 6p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which gives acceptable assumptions that may be used in evaluating the radiological consequences of a coolant loss accident for a pressurized-water reactor. (auth)

11379 (WASH–1226-5) ASSUMPTIONS USED FOR EVALUATING THE POTENTIAL RADIOLOGICAL CONSEQUENCES OF A STEAM LINE BREAK ACCIDENT FOR BOILING WATER REACTORS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 4p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which gives acceptable assumptions that may be used in evaluating the radiological consequences of a steam line break accident for a boiling water reactor. (auth)

11380 (WASH–1226-7) CONTROL OF COMBUSTIBLE GAS CONCENTRATIONS IN CONTAINMENT FOLLOWING A LOSS OF COOLANT ACCIDENT. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 3p. Dep. DRS, USAEC, Washington, D. C.

A standard is presented which describes systems to control hydrogen, oxygen, and other substances which may be released into the reactor containment following postulated accidents to assure that containment integrity is maintained. (auth)

11381 (WASH–1226-8) PERSONNEL SELECTION AND TRAINING. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes an acceptable method of selecting and training power reactor personnel. (auth)

11382 (WASH–1226-12) INSTRUMENTATION FOR EARTHQUAKES. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 10 Mar 1971. 2p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes requirements for earthquake detecting instrumentation for automatic reactor scram. (auth)

11383 (WASH–1226-17) PROTECTION AGAINST INDUSTRIAL SABOTAGE. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 27 Oct 1971. 3p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes a suitable program for protecting power reactors against industrial sabotage. (auth)

11384 (WASH–1226-20) VIBRATION MEASUREMENTS ON REACTOR INTERNALS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 29 Dec 1971. 4p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes preoperational vibration testing requirements for power reactor in-vessel components. (D.C.C.)

11385 (WASH–1226-21) MEASURING AND REPORTING OF EFFLUENTS FROM NUCLEAR POWER PLANTS. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 29 Dec 1971. 6p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the monitoring and reporting requirements for radioactive effluents from power reactors. (auth)

11386 (WASH–1226-28) QUALITY ASSURANCE PROGRAM REQUIREMENTS (DESIGN AND CONSTRUCTION). Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 7 Jun 1972. 1p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes the requirements of a quality assurance program for power reactors. (auth)

11387 (WASH–1226-29) SEISMIC DESIGN CLASSIFICATION. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 7 Jun 1972. 2p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which classifies earthquake stress resisting components and structures of power reactors. (auth)

11388 (WASH–1226-31) CONTROL OF STAINLESS STEEL WELDING. Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 11 Aug 1972. 4p. Dep. DRS, USAEC, Washington, D. C.

A safety guide is presented which describes welding requirements for stainless steel core components in power reactors. (D.C.C.)

11389 (WASH–1226-33) QUALITY ASSURANCE PROGRAM REQUIREMENTS (OPERATION). Safety Guide. (Directorate of Regulatory Standards (AEC), Washington, D. C.). 3 Nov 1972. 6p. Dep. DRS–USAEC, Washington, D. C.

A safety guide is presented which describes the quality assurance program requirements for the operation of power reactors. (auth)

11390 FAILURE ANALYSIS IN POWER PLANTS BY MEANS OF ON-LINE COMPUTERS. Muechler, A. (Gemeinschaftskraftwerk, Kiel); Pickel, E.; Schwarz, H. G. Elektrizitaetswirtschaft; 71: No. 8, 213-18(1972). (In German).

Four examples are given to illustrate the usefulness of on-line computers for rapid failure analysis in power plants. It is shown that the analysis of some failures is only possible by means of data processing. In nuclear power plants, on-line computers are indispensable for an optimum failure analysis. But in larger conventional thermal power plants as well, on-line computers may help to save valuable time and to increase the availability. (GF)

11391 DERIVATION OF THE MAXIMUM PERMISSIBLE ^{41}Ar EMISSION RATE FROM A NUCLEAR REACTOR STACK. Skibin, Dov (Nuclear Research Center-Negev, Beer-Sheva, Israel). J. Nucl. Sci. Technol. (Tokyo); 9: No. 5, 310-11(May 1972).

Steam and Power Conversion Systems

Refer also to abstract 9501.

11392 LIQUID SODIUM–WATER HEAT EXCHANGER. Brachet, A. (to Electricite de France). French Patent 2,112,007. 16 Jun 1972. Filed 3 Apr 1970. (In French).

A liquid-Na–water heat exchanger is described. This exchanger is provided with a series of tubes in which a first heat exchanger fluid (such as water) circulates. These tubes are situated inside an envelope in which a second fluid (e.g., liquid Na) flows. Means are provided in normal operation for maintaining a predetermined free level of liquid in the envelope and a closed inert-gas atmosphere above this liquid. The exchanger also possesses an expansion reservoir situated in a space provided in the envelope between the tubes and at least one overflow for the liquid of the reservoir. (France)

11393 METHOD OF LOCATING STEAM LEAKS IN HEAT EXCHANGERS WITH TUBES IMMERSED IN LIQUID Na. Brachet, A.; Lannou, L. (to Electricite de France). French Patent 2,109,027. 26 May 1972. Filed 3 Dec 1969. (In French).

A method is given for locating a tube with a leak in the tube assembly of a heat exchanger utilizing liquid Na as the primary fluid

and water or steam (circulating inside the tubes) as the secondary fluid. This method enables very small leaks to be detected while minimizing the time during which the installation is out of operation. The faulty tube, once detected, can be plugged at both ends outside the vessel containing the Na. This plugging only slightly reduces the thermal efficiency of the exchanger, this effect being negligible in relation to the large number of tubes constituting the installation. (France)

11394 HEAT EXCHANGERS FOR SODIUM-COOLED NUCLEAR REACTORS. Keusenhoff, J. (to Internationale Atomreaktorbau GmbH). German Patent 2,046,548. 23 Mar 1972. (In German).

A description is given of a heat exchanger which is operated with liquid sodium as a primary medium and with water or respectively steam, as a secondary medium. The heat exchanger is composed of a closed-end main tube for the sodium flow and is provided with a dip pipe. Part of the main tube is surrounded by a jacket encasing tube, thus forming an annular clearance for the water/steam circulation. The submerged part of the tube is composed of three layers. (GF)

11395 STEAM GENERATOR FOR POWER PLANTS HEATED BY NUCLEAR ENERGY. Bredtschneider, Walter (to Siemens Aktiengesellschaft). U. S. Patent 3,682,772. 8 Aug 1972. Priority date 17 Apr 1968, Austria.

A steam generator for power plants heated by nuclear energy includes a reactor core, a pressure housing surrounding the reactor core and having inner space for receiving a supply of feedwater therein, means for passing steam through the reactor core for superheating the steam, and means for heating feedwater located in the inner space with part of the superheated steam so as to turn the feedwater into steam. (Official Gazette)

11396 HEAT EXCHANGER INSTALLATION FOR A REACTOR. (to Babcock-Atlantique). French Patent 2,096,841. 3 Mar 1972. Filed 6 Jul 1970. (In French).

This sodium-cooled heat exchanger installation for a fast reactor consists of a principal vessel housing another vessel which contains the reactor. This internal vessel is provided with extended radial parts for the exchanger elements (parallel tubular panels). A space is provided between the principal vessel and the end parts of each extended part for the passage of the feed tubes; these tubes contain the secondary sodium which arrives cold. The tubes form a continuous cold wall along the inner wall of the principal vessel. (France)

11397 PROBLEMS OF BOILER DEVELOPMENT IN THE FUTURE EVOLUTION OF NUCLEAR POWER STATIONS. Hryniszak, W.; Bitterlich, E. (Clarke, Chapman and Co. Ltd., Gateshead, Eng.). Mitt. VGB; 51: No. 6, 444-54(Dec 1971). (In German).

With reference to the development of British reactor technology the design criteria for boilers, particularly those for gas-cooled reactors, are described. The importance of boiler layout is specially emphasized and the advantages and disadvantages of possible feed controls and steam coil arrangements are discussed. A glimpse at future developments concludes the details. (auth)

Commercial Power Reactors

Refer also to abstracts 9551, 9558, and 9953.

Physics and Core Engineering

11398 (SNE-119) ^{238}Pu PRODUCTION IN COMMERCIAL WATER REACTORS EXPERIMENTAL AND ANALYTICAL PROGRAM. Roach, K. E.; Mullett, W. L.; Brown, G. M.; Maxwell, W. A.; Turner, S. E.; Mitchell III, Walter (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Jul 1972. Contract AT(29-2)-2741. 86p. Dep. NTIS.

Neptunium targets were fabricated and were installed in a fuel assembly to be irradiated in Core 3 of the Connecticut Yankee reactor. The targets were in the core for approximately one year. The targets were removed from the fuel assembly and placed in a storage container in the fuel storage pool at the Connecticut Yankee site. Visual inspection of the targets as they were removed from the fuel assembly indicated no cladding damage, swelling, or other visible effect. Metallurgical evaluations will be carried out, and samples selected on the basis of gamma scans will be analyzed for neptunium-237 and plutonium isotopes, including plutonium-236. Concurrent with the effort leading to the neptunium irradiation, a multi-dimensional model was developed for the analysis of pressurized water reactor cores containing neptunium targets. Core 3 of Connecticut Yankee was modeled in three dimensions, and the burnup of the neptunium targets was followed on a monthly basis. At the same time, a two-dimensional parametric study, which utilized a pressurized water reactor of current design as a base, was started in order to refine the earlier one-dimensional calculations. Four two-dimensional problems were completed, and these calculations give a feasible arrangement of neptunium rods mixed with burnable poison rods. (auth)

Control Elements, Systems, and Instrumentation

11399 CONTROL DEVICES FOR GAS-COOLED NUCLEAR REACTORS. McPhie, J. M. (General Electric Co. Reactor Equipment Ltd., Whetstone, Eng.). J. Sci. Technol. (London); 39: No. 3, 115-24(1972).

A description is given of the design basis of the reactivity control systems of the UK gas-cooled reactors. The development of the control rod mechanisms is traced for five successive nuclear stations, i.e., the Magnox stations at Hinkley Point, Sizewell, Wylfa, and the AGR stations at Hartlepool and Heysham. (UK)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

11400 HOW SAFE ARE PRESSURE VESSELS IN THERMAL POWER STATIONS? Wolff, J. (Technischer Ueberwachungs-Verein Bayern eV, Munich). Mitt. VGB; 51: No. 6, 437-44(Dec 1971). (In German).

Expenditure on testing, energy content, materials, and design, construction and operational influences determine safety in pressure vessels. With the aid of examples it is shown that humans can and must live with such a calculated risk in order to satisfy their demands for energy. (auth)

Operation and Economics

11401 (DOCKET-50003-145) INDIAN POINT STATION, UNIT 1. Technical Specifications, Request for Changes, December 8, 1972 and December 12, 1972. (Consolidated Edison Co. of New York, Inc., New York). 21 Dec 1972. 15p. Dep. NTIS.

Revised technical specifications are presented concerning maintenance procedures for control rod drives and the use of respiratory equipment by personnel. (D.C.C.)

11402 (DOCKET-50003-147) INDIAN POINT STATION, UNIT 1. Alarm Failure on Test Withdrawal of Two Control Rods. (Consolidated Edison Co. of New York, Inc., New York). 28 Dec 1972. 2p. Dep. NTIS.

11403 (DOCKET-50003-148) INDIAN POINT STATION, UNIT 1. Semiannual Operation Report No. 20, April 1, 1972-September 30, 1972. (Consolidated Edison Co. of New York, Inc., New York). 15 Dec 1972. 80p. Dep. NTIS.

11404 (DOCKET-50010-124) DRESDEN NUCLEAR POWER STATION, UNIT 1. Proposed Change to Appendix A, DPR-2 to Permit Operation of Cycle 9. (Commonwealth Edison Co., Chicago, Ill.). 3 Jan 1973. 4p. Dep. NTIS.

Revised technical specifications are presented concerning the fuel element loading configuration for Cycle 9 operation. (D.C.C.)

11405 (DOCKET-50010-125) DRESDEN NUCLEAR POWER STATION, UNIT 1. Release of ^{131}I. (Commonwealth Edison Co., Morris, Ill. (USA)). 9 Jan 1973. 1p. Dep. NTIS.

11406 (DOCKET-50010-126) DRESDEN NUCLEAR POWER STATION, UNIT 1. Fuel Densification Effect. (Commonwealth Edison Co., Chicago, Ill.). 5 Jan 1973. 8p. Dep. NTIS.

11407 (DOCKET-50029-219) YANKEE NUCLEAR POWER STATION. During Surveillance Test Solenoid Valve Failed to Operate October 26, 1972. Damage to a Fuel Assembly October 31, 1972. Two Control Rod Shroud Tubes Displaced November 13, 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 26 Dec 1972. 8p. Dep. NTIS.

11408 (DOCKET-50029-220) YANKEE NUCLEAR POWER STATION. Operation Report 143, November 1972. (Yankee Atomic Electric Co., Westboro, Mass.). 3 Jan 1973. 8p. Dep. NTIS.

11409 (DOCKET-50213-170) HADDAM NECK PLANT, UNIT 1. Technical Specifications, Proposed Change 21. (Connecticut Yankee Atomic Power Co., Hartford). 8 Dec 1972. 11p. Dep. NTIS.

Revised technical specifications are presented concerning reporting requirements for reactor operations. (D.C.C.)

11410 (DOCKET-50219–224) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Floor Drain Sample Tank, Recycle Line Failure. (Jersey Central Power and Light Co., Morristown, N. J.). 19 Dec 1972. 2p. Dep. NTIS.

11411 (DOCKET-50237–285) DRESDEN NUCLEAR POWER STATION, UNIT 2. Control Rod Difficulties. (Commonwealth Edison Co., Chicago, Ill.). 14 Dec 1972. 2p. Dep. NTIS.

11412 (DOCKET-50245–176) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Chloride Intrusion Incident Special Report, Appendices. (Millstone Point Co., Hartford, Conn.). 11 Dec 1972. 185p. Dep. NTIS.

Information is presented concerning the effects of salt water on the reactor cooling system components. (D.C.C.)

11413 (DOCKET-50245–177) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Change. (Millstone Point Co., Hartford, Conn.). 8 Dec 1972. 13p. Dep. NTIS.

Revised technical specifications are presented concerning administrative controls and reporting requirements for reactor operations. (D.C.C.)

11414 (DOCKET-50249–180) DRESDEN NUCLEAR POWER STATION, UNIT 3. Dilution of Boron in Standby Liquid Control Tank, January 3, 1973; Switches Out of Calibration, January 9, 1973 and January 10, 1973. (Commonwealth Edison Co., Morris, Ill. (USA)). 10 Jan 1973. 3p. Dep. NTIS.

11415 (DOCKET-50254–154) QUAD-CITIES STATION, UNITS 1 AND 2. Failure of Main Chimney Sampling System. (Commonwealth Edison Co., Cordova, Ill.). 18 Dec 1972. 3p. (DOCKET-50265–143). Dep. NTIS.

11416 (DOCKET-50254–155) QUAD-CITIES STATION, UNIT 1. Small Fire in Motor of Water Pumps; Oil Pressure Switch Recalibrated. (Commonwealth Edison Co., Cordova, Ill.). 30 Dec 1973. 5p. Dep. NTIS.

11417 (DOCKET-50255–124) PALISADES PLANT. Interim Special Technical Specifications, Proposed Change 5. (Consumers Power Co., Jackson, Mich.). 3 Jan 1973. 27p. Dep. NTIS.

Revised technical specifications are presented concerning operations under the 2200 MW(t) power level limit. (D.C.C.)

11418 (DOCKET-50255–125) PALISADES PLANT. Monthly Primary and Secondary Radioactivity and Effluent Report, November 1972. (Consumers Power Co., Jackson, Mich.). 21 Dec 1972. 2p. Dep. NTIS.

11419 (DOCKET-50255–126) PALISADES PLANT. Technical Specifications, Proposed Change 4. (Consumers Power Co., Jackson, Mich.). 21 Dec 1972. 10p. Dep. NTIS.

Revised technical specifications are presented concerning instrumentation requirements for reactor start-up. (D.C.C.)

11420 (DOCKET-50255–127) PALISADES PLANT. Unplanned Release from "C" Waste Gas Tank. (Consumers Power Co., Jackson, Mich.). 27 Dec 1972. 2p. Dep. NTIS.

11421 (DOCKET-50259–72) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Fuel Densification Effect. (Tennessee Valley Authority, Chattanooga). 2 Jan 1973. 16p. (DOCKET-50260–68; DOCKET-50296–66). Dep. NTIS.

11422 (DOCKET-50261–128) H. B. ROBINSON UNIT 2. Final Report on Boron Injection Tank Dilution Incident of July 16, 1972; Malfunction of Power Operated Relief Valve; Hot Leg Injection Defeat. (Carolina Power and Light Co., Raleigh, N. C.). 29 Nov 1972. 6p. Dep. NTIS.

11423 (DOCKET-50263–165) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Loss of Stack Gas Monitoring System. (Northern States Power Co., Minneapolis, Minn.). 15 Dec 1972. 2p. Dep. NTIS.

11424 (DOCKET-50271–124) VERMONT YANKEE NUCLEAR POWER STATION. Pressure Switch Actuated Below Specified Pressure. (Vermont Yankee Nuclear Power Corp., Rutland). 13 Dec 1972. 1p. Dep. NTIS.

11425 (DOCKET-50271–125) VERMONT YANKEE NUCLEAR POWER STATION. Auxiliary Transformer Extensively Damaged by Fire. (Vermont Yankee Nuclear Power Corp., Rutland). 13 Dec 1972. 5p. Dep. NTIS.

11426 (DOCKET-50280–96) SURRY POWER STATION, UNIT 1. Abnormal Occurrences, Leak in Containment, and Portion of Main Steam Safety Valve System Inoperable. (Virginia Electric and Power Co., Richmond). 7 Dec 1972. 25p. Dep. NTIS.

11427 (DOCKET-50280–97) SURRY POWER STATION, UNIT 1. Fish Mortalities. (Virginia Electric and Power Co., Richmond). 18 Dec 1972. 8p. Dep. NTIS.

11428 (DOCKET-50293–108) PILGRIM NUCLEAR POWER STATION. Changes in Calibration of Steam Relief Valves; Changes in Calibration of Differential Pressure Switches. (Boston Edison Co., Mass.). 15 Dec 1972. 4p. Dep. NTIS.

11429 (DOCKET-50309–85) MAINE YANKEE ATOMIC POWER STATION. Leakage of Boron into Safety Injection Tank No. 1. (Maine Yankee Atomic Power Co., Wiscasset). 7 Dec 1972. 3p. Dep. NTIS.

11430 (DOCKET-50309–86) MAINE YANKEE ATOMIC POWER STATION. Failure of Pump to Start December 2, 1972; Steam Dump Temperature Control Valves Opened December 2, 1972; Safety Injection Tank Pressure Decreased Due to Ambient Temperature Decrease December 8, 1972. (Maine Yankee Atomic Power Co., Wiscasset). 18 Dec 1972. 5p. Dep. NTIS.

11431 (DOCKET-50321–63) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Application for a Construction Permit and Operating License, Amendment 25. (Georgia Power Co., Atlanta). 14 Dec 1972. 154p. Dep. NTIS.

Estimated costs for the reactor are presented. Financial data on the owners of the reactor are included. (D.C.C.)

11432 IN-SERVICE INSPECTION OF THE BR 3 REACTOR IN MOL. Watkins, B. (United Kingdom Atomic Energy Authority, Risley, Eng.). Atom (London); No. 188, 110-14(Jun 1972).

In Dec. 1971 an inspection of parts of the pressure vessel and the reactor internals of the Belgian BR 3 reactor, which is a pressurized water reactor designed to produce gross electrical power of 11.5 MW, was undertaken. The inspection was done after removal of the third core and information obtained was used in the revalidation of the pressure vessel. A full closed circuit television examination of the pressure vessel interior surface and of the accessible parts of the reactor was carried out and also volumetric ultrasonic examinations of one inlet nozzle and part of one longitudinal weld. Both ultrasonic and eddy current techniques were used to inspect 30% of the closure studs and nuts. All inspections except for the nuts and studs were done under 5 to 50 ft water. (UK)

11433 CONCEPTUAL DESIGN OF A NUCLEAR POWER PLANT FOR UNDERGROUND APPLICATION. Smith, C. D. (Office, Chief of Engineers, Washington, DC); Greenberg, M. M. pp 17,5-10 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

A conceptual design is presented, based on current reactor technology, of a nuclear power plant applicable to hardened underground application. The concept is for a total energy system, i.e., a complete power generating system, including the energy source, and an integral waste heat rejection system. The power plant, designed to sustain a nuclear attack, is not only self-sustaining but capable of providing 1500 KW of export electrical power to a vital installation. The primary system utilizes a reactor core consisting of pellet type fuel elements with a design life of 50 MW years. The secondary system based on a steam Rankine Cycle is conventional in design except for the heat rejection system. Cost comparisons of above and below ground fossil-fuel and nuclear power plants are included. (auth)

Safety and Siting

11434 (DOCKET-50003–146) INDIAN POINT STATION, UNIT 1. Capacities of Emergency Primary Makeup Pumps. (Consolidated Edison Co. of New York, Inc., New York). 12 Dec 1972. 3p. Dep. NTIS.

11435 (DOCKET-50029–217) YANKEE NUCLEAR POWER STATION. Reply to Letter of November 17, 1972 Relative to March 1972 Inservice Inspection Examination. (Yankee Atomic Electric Co., Westboro, Mass.). 1 Dec 1972. 3p. Dep. NTIS.

Information is presented concerning the inspection of loading system welds and pressurizer clad. (D.C.C.)

11436 (DOCKET-50206–177) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Addition of Onsite Power Sources. (Southern California Edison Co., Rosemead, Calif.). 18 Dec 1972. 2p. Dep. NTIS.

11437 (DOCKET-50220-117) NINE MILE POINT NUCLEAR STATION, UNIT 1. Notice of Consideration of Conversion of Provisional Operating License to Full-Term Operating License; Notice of Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 5 Dec 1972. 9p. Dep. NTIS.

11438 (DOCKET-50237-286) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. QUAD-CITIES STATION, UNITS 1 AND 2. Scram Reactivity Limitations. (Commonwealth Edison Co., Chicago, Ill.). 18 Dec 1972. 2p. (DOCKET-50249-177; DOCKET-50254-151; DOCKET-50265-140). Dep. NTIS.

11439 (DOCKET-50237-287) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Technical Specifications, Change 18 to License DPR-19; Technical Specifications, Change 10 to License DPR-25. (Directorate of Licensing (AEC), Washington, D. C.). 4 Dec 1972. 9p. (DOCKET-50249-178). Dep. NTIS.

Revised technical specifications are presented concerning the environmental radiation monitoring program. (D.C.C.)

11440 (DOCKET-50245-178) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Chloride Intrusion Incident Special Report. (Millstone Point Co., Hartford, Conn.). 11 Dec 1972. 387p. Dep. NTIS.

Additional information is presented concerning the effects of salt water on the reactor cooling system. (D.C.C.)

11441 (DOCKET-50250-107) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Supplement 54. (Florida Power and Light Co.). 13 Dec 1972. 2p. (DOCKET-50251-87). Dep. NTIS.

A revised flow diagram for the steam systems is presented. (D.C.C.)

11442 (DOCKET-50251-90) TURKEY POINT PLANT, UNIT 4. Order Extending Construction Completion Date to January 1, 1974. (Directorate of Licensing (AEC), Washington, D. C.). 27 Dec 1972. 3p. Dep. NTIS.

11443 (DOCKET-50254-152) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Change 4. (Directorate of Licensing (AEC), Washington, D. C.). 14 Dec 1972. 294p. (DOCKET-50265-141). Dep. NTIS.

Revised technical specifications are presented for 2511 MW(t) operation. (D.C.C.)

11444 (DOCKET-50255-122) PALISADES PLANT. Technical Specifications, Proposed Change 3. (Consumers Power Co., Jackson, Mich.). 18 Dec 1972. 20p. Dep. NTIS.

Revised technical specifications are presented concerning trip points for engineered safeguards and reactor protection system. (D.C.C.)

11445 (DOCKET-50259-71) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 45. (Tennessee Valley Authority, Chattanooga). 19 Dec 1972. 177p. (DOCKET-50260-67; DOCKET-50296-65). Dep. NTIS.

Revised and additional data are presented concerning emergency systems, structures, auxiliary systems, and electrical systems. (D.C.C.)

11446 (DOCKET-50269-80) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 37. (Duke Power Co., Charlotte, N. C.). 15 Nov 1972. 214p. (DOCKET-50270-66; DOCKET-50287-58). Dep. NTIS.

Revised and additional data are presented concerning the electrical systems, safety analysis, pressurized fuel elements, and administrative controls of operation. (D.C.C.)

11447 (DOCKET-50269-82) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Steps Taken With Respect to Items of Noncompliance Brought to Attention by Letter Dated October 26, 1972. (Duke Power Co., Charlotte, N. C.). 24 Nov 1972. 11p. (DOCKET-50270-69; DOCKET-50287-61). Dep. NTIS.

11448 (DOCKET-50289-82) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 35. (Metropolitan Edison Co., Reading, Pa.). 19 Dec 1972. 88p. Dep. NTIS.

Revised and requested data are presented concerning radioactive effluents, safety analysis, fire protection system, engineered safeguards, and containment system. (D.C.C.)

11449 (DOCKET-50302-59) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Review with Respect to Failure of Non-Category I (Seismic) Equipment. (Florida Power Corp., St. Petersburg). 19 Dec 1972. 5p. Dep. NTIS.

The effects of failures in non-category 1 equipment on the performance of engineered safeguards are analyzed. (D.C.C.)

11450 (DOCKET-50305-61) KEWAUNEE NUCLEAR POWER PLANT. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 357p. Dep. NTIS.

The environmental effects of construction and operation of the Kewaunee Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

11451 (DOCKET-50313-60) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 33. (Arkansas Power and Light Co., Little Rock). 21 Dec 1972. 206p. Dep. NTIS.

Revised and requested data are presented concerning the emergency plans for the reactor. (D.C.C.)

11452 (DOCKET-50317-74) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 31. (Baltimore Gas and Electric Co., Md.). 18 Dec 1972. 35p. (DOCKET-50318-71). Dep. NTIS.

Revised data are presented concerning core physics, containment structure, auxiliary systems, and emergency plans. (D.C.C.)

11453 (DOCKET-50317-75) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Action Taken to Improve Effectiveness of Quality Assurance Program. (Baltimore Gas and Electric Co., Md.). 29 Nov 1972. 15p. (DOCKET-50318-72). Dep. NTIS.

11454 (DOCKET-50321-62) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 24. (Georgia Power Co., Atlanta). 13 Dec 1972. 58p. Dep. NTIS.

Revised and requested data are presented concerning electrical systems, auxiliary systems, core physics, cooling system, containment system, and earthquake stress characteristics of structures. (D.C.C.)

11455 (DOCKET-50331-68) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 10. (Iowa Electric Light and Power Co., Cedar Rapids). 11 Dec 1972. 260p. Dep. NTIS.

Revised and requested data are presented concerning emergency plans, instrumentation, site, containment system, radioactive waste disposal system, auxiliary systems, safety analysis, engineered safeguards, quality assurance program, and earthquake stress analysis for structures. (D.C.C.)

11456 (DOCKET-50333-72) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Inspection of Pipe Fittings. (Power Authority of the State of New York). 20 Nov 1972. 10p. Dep. NTIS.

11457 (DOCKET-50333-73) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 18. (Power Authority of the State of New York). 22 Dec 1972. 96p. Dep. NTIS.

Requested additional data are presented concerning electrical systems, cooling system, personnel, and safety analysis of control rod drop accident. (D.C.C.)

11458 (DOCKET-50334-49) BEAVER VALLEY POWER STATION, UNIT 1. Environmental Report, Amendment 4. (Duquesne Light Co., Pittsburgh, Pa.). 13 Dec 1972. 235p. Dep. NTIS.

11459 (DOCKET-50335-36) ST. LUCIE PLANT, UNIT 1. Failure of No Non-Category I Equipment Could Cause Degradation of Safety Related Equipment. (Florida Power and Light Co.). 27 Oct 1972. 2p. Dep. NTIS.

11460 (DOCKET-50335-37) ST. LUCIE PLANT, UNIT 1. Environmental Report, Supplement 8. (Florida Power and Light Co.). 25 Oct 1972. 7p. Dep. NTIS.

The environmental report for the St. Lucie Power Reactor, Unit 1 is supplemented by the submission of plans for a third transmission line crossing the Indian River. (H.D.R.)

11461 (DOCKET-50335-38) ST. LUCIE PLANT, UNIT 1. Containment Vessel Post Weld Heat Treatment and Diesel Generator Testing. (Florida Power and Light Co.). 7 Dec 1972. 4p. Dep. NTIS.

11462 (DOCKET-50354-33) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Environmental Report,

Amendment 4. (Public Service Electric and Gas Co., Newark, N. J.). 4 Dec 1972. 9p. (DOCKET-50355-32). Dep. NTIS.

Revised information is presented concerning the distribution patterns of thermal discharges in the Delaware River. (D.C.C.)

11463 (DOCKET-50354-34) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Dec 1972. 323p. (DOCKET-50355-33). Dep. NTIS.

The environmental effects of construction and operation of the Newbold Island Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

11464 (DOCKET-50382-46) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 28. (Louisiana Power and Light Co., New Orleans). 18 Dec 1972. 34p. Dep. NTIS.

Additional data are presented concerning piping systems and soil characteristics at the reactor site. (D.C.C.)

11465 (DOCKET-50382-47) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Environmental Report, Supplement 3. (Louisiana Power and Light Co., New Orleans). 15 Dec 1972. 106p. Dep. NTIS.

11466 (DOCKET-50395-33) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 18. (South Carolina Electric and Gas Co., Columbia). 4 Dec 1972. 115p. Dep. NTIS.

Revised and additional data are presented concerning electrical systems, containment structures, and soil characteristics for the reactor site. (D.C.C.)

11467 (DOCKET-50398-27) MENDOCINO POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 17. (Pacific Gas and Electric Co., San Francisco, Calif.). 8 Dec 1972. 65p. (DOCKET-50399-27). Dep. NTIS.

Revised and requested data are presented concerning the quality assurance program, engineered safeguards, electrical systems, and earthquake stress analysis for structures. (D.C.C.)

11468 (DOCKET-50410-16) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Amendment 4. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 7 Dec 1972. 161p. Dep. NTIS.

Revised and requested data are presented concerning diesel generators, service water system, fuel storage facility, remote handling equipment, fire protection system, and mechanical structures. (D.C.C.)

11469 (DOCKET-50412-3) BEAVER VALLEY POWER STATION, UNIT 2. Environmental Report, Amendment 1. (Duquesne Light Co., Pittsburgh, Pa.). 13 Dec 1972. 30p. Dep. NTIS.

11470 (TID-26224) STANDARD FORMAT AND CONTENT OF SAFETY ANALYSIS REPORTS FOR NUCLEAR POWER PLANTS (Revision 1). (Atomic Energy Commission, Washington, D. C.). Oct 1972. 237p. Dep. NTIS.

The Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants has been prepared by the AEC regulatory staff to provide a uniformity in Safety Analysis Reports (SAR) submitted as part of applications for construction permits and operating licenses for nuclear power plants, and to indicate the information to be provided in the reports. The principal purpose for the preparation and submittal of an SAR is to inform the Commission of the nature of the plant and plans for its use. The information provided in the SAR must be sufficient to permit a review of whether the plant can be built and operated without undue risk to the health and safety of the public. Prior to submission of an SAR an applicant should have evaluated the plant in sufficient detail to conclude that it can be built and operated safely. The SAR is the principal document whereby the applicant provides the information needed to understand the basis upon which this conclusion has been reached. In the Standard Format, the SAR is divided into seventeen chapters (e.g., Chapter 2.0 Site Characteristics). Within the chapters the material is arranged in sections (e.g., 2.4 Hydrology), subsections (e.g., 2.4.2 Floods), and further subdivisions. (auth)

11471 FIRST NUCLEAR POWER PLANT IN BRAZIL. Simon, D. N.; Wilberg, J. A. (FURNAS, Rio de Janeiro). Nucl. Eng. Int.; 17: No. 198, 935-8(Nov 1972).

The background to the decision to build a nuclear power station in Brazil is reviewed. Details are given of the site investigation leading to the choice of a coastal site near Angra dos Reis. The assessment of six international bids, which resulted in the choice of a Westinghouse PWR for the Angra Unit No. 1, is described. Brief reference is made to safety requirements, fuel supplies, and estimated cost of the project. (UK)

11472 NUCLEAR SAFETY AND THE PUBLIC INTEREST. Green, Harold P. (George Washington Univ., Washington, D. C.). Nucl. News: 15: No. 9, 75-8(Sep 1972).

A personal view is presented of the risks of nuclear power and the current crisis in plant licensing. Some of the objective and subjective factors in the public distrust of nuclear power are described. The political influence of the JCAE and its effect on public discussion of risks from 1954 to 1969 are pointed out. Present public hearings on reactor licensing are criticized in that only the intervenors bring up the risks. Several suggestions are made for improvements in procedures, such as discussing risks fully with public in understandable terms and letting it participate in the benefit/risk decisions. (D.L.C.)

11473 RADIOACTIVITY AND RADIATION PROTECTION IN A BWR INSTALLATION. Eickelpasch, Norbert (Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.). At. Strom.; 18: No. 9-10, 122-7(1972). (In German).

On the basis of the experience gained in the operation of the Gundremmingen nuclear power station for nearly six years, the type and magnitude of the radioactivity produced as well as the problems in radiation protection are discussed. Details are given of the effects of radioactivity on the installation when in operation i.e., the power dosage on parts of the installation and in rooms, the aerosol activity and the radioactivity transmitted to the outside. The difficulties in maintenance and supervisory work during the annual overhaul are dealt with, which are due to radioactive pollution of the circulation channels, the effect of the dosage on the repair personnel, and a few suggested improvements. (auth)

Steam and Power Conversion System

Refer also to abstract 9454.

11474 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Beresford-Hartwell, Geoffrey Michael; Nichols, Ronald William (to Atomic Power Constructions Ltd.). British Patent 1,284,871. 9 Aug 1972. Filed 30 Aug 1968.

Reference is made to load-following controllers for use in high-temperature gas-cooled reactor power plants for raising steam. Means are provided to respond to a change in steam flow rate requirements, adjust a steam flow control valve, the mass flow rate of the primary coolant passing through the reactor core, and the mass flow rate of feedwater. Further means are provided for adjusting the mass flow rate of the primary coolant in response to a control signal derived from the temperature of steam leaving the heat exchange means. The steam flow control valve may comprise a turbine throttle valve. The system is designed to operate in conjunction with a reactor of short-term or prompt negative temperature coefficient and to permit variation of reactor primary coolant outlet temperature, a result of which mode of operation is that control rod movements are not required. (UK)

11475 EXPERIENCE FROM RESEARCH, MANUFACTURE, AND OPERATION OF GAS-HEATED STEAM GENERATORS FOR NUCLEAR POWER STATIONS. Weber, M.; Frei, H.; Profos, O. (Gebrueder Sulzer AG, Winterthur, Switzerland). Mitt. VGB; 51: No. 6, 455-65(Dec 1971). (In German).

By way of introduction the overall problems contained in a steam generator contract are outlined and a survey is made of the aging factors which affect the steam generator. The sections which follow examine soundness of construction, vibration, stability, and thermal fatigue and show that these problems can be overcome thanks to analyses, experiments, and operational experience. (auth)

Propulsion and Auxiliary Power Reactors

Refer also to abstracts 9468, 9940, 9948, 9965, and 10019.

11476 (GULF-GA-A-11073) DEVELOPMENT OF A THERMIONIC REACTOR SPACE POWER SYSTEM. Summary Report, November 1, 1971-February 29, 1972. (Gulf General Atomic Co., San Diego, Calif.). 31 Jul 1972. Contract AT(04-3)-840. 264p. Dep. NTIS.

The fabrication and testing programs for UC–ZrC thermionic fuel elements for space power systems are reviewed. (D.C.C.)

11477 (N–72-24809) PRECOMPUTED STATE DEPENDENT DIGITAL CONTROL OF A NUCLEAR ROCKET ENGINE. Semi-annual Report. Johnson, M. R. (Arizona Univ., Tucson. Engineering Experiment Station). Jun 1972. 163p. (NASA-CR–126649). NTIS.

A control method applicable to multiple-input multiple-output nonlinear time-invariant systems in which desired behavior can be expressed explicitly as a trajectory in system state space is developed. The precomputed state dependent control method is basically a synthesis technique in which a suboptimal control law is developed off-line, prior to system operation. This law is obtained by conducting searches at a finite number of points in state space, in the vicinity of some desired trajectory, to obtain a set of constant control vectors which tend to return the system to the desired trajectory. These vectors are used to evaluate the unknown coefficients in a control law having an assumed hyperellipsoidal form. The resulting coefficients constitute the heart of the controller and are used in the on-line computation of control vectors. Two examples of PSDC are given prior to the more detailed description of the NERVA control system development. (auth)

11478 (TID–26214) RELIABILITY PLAN. (Aerojet Nuclear Systems Co., Sacramento, Calif.). Sep 1970. Contract SNP-1. 99p. Dep. NTIS.

The reliability plan was prepared to implement those portions of reliability methodology that will optimize available resources in developing a highly reliable NERVA engine system. The general approach presented is: (a) to perform detailed system-and-component-level failure-mode and single-failure-point analyses, early in the systems-analysis phase, to identify critical modes of failure and trend characteristics; (b) to determine the priority rating of each failure-mode in terms of system criticality, probability of failure, and part weight, which will then determine the degrees of subsequent analysis and testing for each mode; (c) to implement a probabilistic approach to component design for these critical failure modes that will include statistical propagation-of-error analysis for engine-system state points and performance parameters; (d) to statistically design material and component testing; and (e) to apply rigorous failure reporting, analysis, and corrective-action procedures and trend analysis during the development phase. In general the methods and plans developed apply to analysis of the NERVA engine system as well as to each major subsystem and component within the engine. The approach presented is equally applicable to vehicle mission studies. The procedures needed to implement the reliability methodology are developed along with the maturing design process and are published as required throughout the program. At periodic intervals the procedures are issued in the NERVA Reliability Procedures Handbook. (auth)

11479 EVALUATION OF THE FUTURE OF NUCLEAR POWER FOR PROPULSION OF MERCHANT SHIPS. Motor Ship; 53: No. 628, 367-8(Nov 1972).

A brief review, based on information presented at an international symposium on nuclear ships held in Madrid, April 1972, describes the state of the art of merchant nuclear propulsion. The commercial viability of nuclear-powered ships, developments in PWR design, studies of nuclear vessel design, and the question of safety are outlined. (UK)

11480 RADIATION SHIELDING STUDY FOR AN INTEGRAL-TYPE MARINE REACTOR. A STUDY OF SECONDARY STEAM SYSTEM CONDITIONS FOR THE REDUCTION OF SHIELD WEIGHT AROUND THE MAIN CONDENSER. Ueki, Kohtaro; Yamakoshi, Hisao (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo Hokoku; 9: No. 1, 1-17(Jan 1972). (In Japanese).

The activation strength of secondary steam generators for integral type ship reactors is analyzed. The activation strength is dependent both on the relative position of the steam generator against the active core as well as the temperature of secondary water at the inlet of the steam generator, once conditions are fixed for active core and circumstance around the steam generator. As a consequence of analysis on the dependence of the activation strength, desirable conditions for lessening the amount of activation are suggested both for the position of the steam generator and the temperature of secondary water. It is also pointed out that the shape of the hot well of the main condenser is responsible for the shield weight and the area of controlled zone around the hot well even for the same strength of the decayed gamma-ray source. From the view point of lessening the shield weight and the controlled zone, discussion is also focused on the shape of the hot well ideal for minimizing the shield weight and the controlled zone simultaneously. For the calculation of reaction rate of $^{16}O(n,p)^{16}N$ occurring in the secondary steam in the steam generator, ray analysis method is adopted for evaluating the neutron flux, where neutron energy supposedly ranges from 10 MeV to 18 MeV. (auth)

11481 STARTUP TESTING OF THE SNAP-8 POWER CONVERSION SYSTEM. Hurrell, H. G.; Boecker, F. Jr.; Jefferies, K. S. (Lewis Research Center, Cleveland). pp 11.28-34 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912–(Vol.1).

SNAP-8 development has included extensive startup testing of the power conversion system coupled with a reactor simulator. Data are presented that show the power conversion system can be started in a dependable way. The temperature transients are well within the limits specified for the reactor. Procedures are discussed for the relatively fast transient to self-sustained operation and for the more gradual transient that achieves rated power output. (auth)

11482 DESIGN CHANGES IN SNAP-8 FOR REDUCED REACTOR OPERATING TEMPERATURES. Thur, G. M. (Lewis Research Center, Cleveland). pp 11.35-8 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912–(Vol.1).

The SNAP-8 mercury Rankine system is a nuclear-electric power conversion system designed to explore the principles and technologies required for electric power production in space using liquid metals as working fluids. The current system is designed to produce a net electrical output of 35 kWe. A number of system changes are presently being considered by NASA as a result of endurance testing of the two most recent zirconium hydride (ZrH) reactors. The design changes and the resulting performance is discussed. (auth)

11483 SNAP-8 ROTATING MACHINERY COMPONENTS: 10,000 HOUR ENDURANCE ACHIEVEMENT. Pope, J. R. (Aerojet Nuclear Systems Co., Azusa, CA); Stromquist, A. pp 11.67-70 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912–(Vol.1).

In August of 1969 the SNAP-8 turbine-alternator passed its design objective of 10,000 operating hours without maintenance, thus becoming the last of the major SNAP-8 rotating machinery components to exceed the original SNAP-8 goal of 10,000 hours operation. Included are the sodium-potassium (NaK) pump, and the mercury pump. The current goal for SNAP-8 is five years without maintenance, and test results so far have revealed no major obstacles in achieving this. The design and testing of these components, including post-endurance evaluations are reported. It is concluded that the rotating machinery and associated seals, with organically lubricated ball bearings of the turbine-alternator and mercury pump, and the tilting pad bearings of the sodium-potassium canned motor pumps are suitable for operation in long-term space applications. (auth)

11484 OPERATION EXPERIENCE WITH NaK-LUBRICATED JOURNAL AND THRUST BEARINGS FOR A NaK PUMP-MOTOR ASSEMBLY. Mah, C. S.; Pope, J. R. (Aerojet Nuclear Systems Co., Azusa, CA). pp 11.71-3 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912–(Vol.1).

The operational experience with bearings lubricated with high temperature sodium-potassium alloy (NaK-78) is described. The journal bearings are segmented, hydrodynamic fluid film, tilting-pad type; the thrust bearings are Kingsbury-type with self-alignment features. The operational experience includes development testing and separate endurance tests of 3,000 and 10,000 hours. Minor development problems were encountered in startups, but the bearings were in usable condition after the 3,000 and 10,000-hour tests. (auth)

11485 EXPERIMENTAL EVALUATION OF TANTALUM/STAINLESS STEEL MERCURY BOILERS FOR THE SNAP-8 SYSTEM. Furman, E. R. (Lewis Research Center, Cleveland); Brooks, R. D.; Harrison, R. W. pp 11.74-9 of Energy 70, Proceedings. Vol. 1. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering

conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.1).

The greatest difficulties encountered in the utilization of mercury as the working fluid in a Rankine system have been the repeatability of the degree of fluid wetting of the heat transfer surfaces and the corrosion of the containment material by the working fluid. A mercury boiler has been designed for the SNAP-8 system which utilizes tantalum for mercury containment. Four boilers of this design, designated as Serial No. 1, 2, 3, and 4, have been successfully tested over a wide range of operating conditions which encompasses the SNAP-8 system requirements. The Serial No. 1 unit was tested in a system loop at LeRC for 1444 hours and in a component test loop at the General Electric Company-Evendale for 13,661 hours. The Serial No. 2 unit was tested in the Power Conversion System Loop at Aerojet-General Corporation-Azusa for a period of 8700 hours and a total of 27 startups. Thus, the Serial No. 1 and 2 boilers have accumulated a combined total of over 23,000 hours at SNAP-8 system conditions. A third unit, Serial No. 3, which was utilized for system startup investigations at LeRC was subjected to 157 hours of operation and 135 startups and shutdown cycles. Based on the performance of the first three units, a new unit, the Serial No. 4, was built and tested in the PCS-1 test facility of AGC-Azusa. The performance of the boilers and the post-test physical and metallurgical examinations of Serial Nos. 1 and 2 are discussed. The design modifications and performance of Serial No. 4 boiler are briefly reviewed. (auth)

11486 TECHNOLOGY STATUS: ZrH SPACE POWER REACTOR. Detterman, R. L. (Atomics International, Canoga Park, CA); Makl, L. M.; Wilson, R. F.; Reardon, D. E. pp 12.26-32 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The ZrH reactor is currently being considered as the heat source for large nuclear electric power supplies for manned space stations. Emphasis in the program is in manrating the reactor and carrying out the development and testing of peripheral components to 20,000 or more hours of demonstrated performance. The results of various integral reactor tests in the program are discussed and compared. Of particular interest is the recent operation of the S8DR reactor. The current technology of the program is evaluated and the various performance envelopes of the reactor discussed. (auth)

11487 REACTOR-THERMOELECTRIC POWER SYSTEMS FOR NASA SPACE STATION/SPACE BASE. Gylfe, J. D. (Atomics International, Canoga Park, CA); Johnson, R. A.; Kitterman, W. L. pp 12.33-40 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Reactor thermoelectric power systems designed for potential use on the NASA Space Station and Space Base are described. The power level requirements per reactor system for these two spacecraft are 33 and 66 kwe (gross), respectively. Both system designs use the Reference Zr-Hydride Reactor coupled to tubular, lead telluride thermoelectric converters and can be launched and/or resupplied by the Advanced Logistics System (ALS or Shuttle). (auth)

11488 LOW-TEMPERATURE-REACTOR BRAYTON CYCLE FOR SPACE STATION/BASE APPLICATION. McCormick, J. E.; Ashe, T. L. (AiResearch Mfg. Co. of Arizona, Phoenix). pp 12.41-8 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

A study was performed to define and optimize the Brayton cycle for use in higher power level applications (25 to 100 kw_e), with a relatively low temperature heat source, namely a 1000 to 1200°F zirconium-hydride reactor. From the results of the study, it must be concluded that the low temperature reactor Brayton cycle is competitive on a productivity (kw-hr/lb) basis. High productivity is the result of high Brayton cycle efficiency, (20 to 30 percent), even at these low reactor operating temperatures. Reduction of reactor thermal power requirements at low operating temperature increases reactor life expectancy. Also, included is a description of a sophisticated Brayton cycle design optimization. Parametric data is presented showing the methods followed to determine such key thermodynamic parameters as rotating speed, recuperator effectiveness, pressure drop distribution and working fluid molecular weight. (auth)

11489 66 kWe ZrH REACTOR-ORGANIC RANKINE POWER SYSTEMS FOR LARGE MANNED ORBITING SPACE SYSTEMS. Moss, T. A. (North American Rockwell Corp., Canoga Park, CA); Wilson, R. F.; Niggemann, R. E. pp 12.49-57 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

A system analysis and conceptual design of a ZrH-reactor/organic Rankine space power system suitable for application on large orbiting Space Base systems is presented. Changes in conversion system performance, weight, and radiator area are discussed for various design parameters. Design and performance of major components are reviewed and a conceptual layout of the total nuclear-organic Rankine system is shown. Performance maps are given for the combined system showing tradeoffs between reactor outlet temperature, reactor lifetime, turbine inlet temperature, turbine exhaust pressure, radiator area, and system weight. (auth)

11490 MODULAR SPACE STATION/BASE ELECTRICAL POWER SYSTEM REQUIREMENTS AND DESIGN STUDY. Eliason, J. T.; Adkisson, W. B. (Sperry Rand Space Support Div., Huntsville, AL). pp 12.58-62 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The requirements and procedures necessary for the definition and specification of an electrical power system (EPS) for the future space station are discussed herein. The considered space station EPS consists of a replaceable main power module with self-contained auxiliary power, guidance, control, and communication subsystems. This independent power source may "plug into" a space station module which has its own electrical distribution, control, power conditioning, and auxiliary power subsystems. Integration problems are discussed, and a transmission system selected with local floor-by-floor power conditioning and distribution in the station module. This technique eliminates the need for an immediate long range decision on the ultimate space base power source(s) by providing capability for almost any currently considered option. (auth)

11491 PRELIMINARY DESIGN OF REACTOR POWER SYSTEMS FOR THE MANNED SPACE BASE. McKhann, G. G.; Coggi, J. V.; Diamond, S. D. (McDonnell Douglas Astronautics Co., Huntington Beach, CA). pp 12.71-9 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The results of design integration studies of uranium-zirconium hydride (UZr-Hx) reactor power systems for the NASA Space Base study program are presented. The power conversion systems investigated include the Brayton cycle, the organic Rankine cycle, the SNAP-8 mercury Rankine cycle, and thermoelectric (PbTe). The proposed Space Base has a 10-year life and requires 100 kwe of power. Two 50-kwe power systems with a nominal replacement life of 5 years are utilized. Parametric design data such as life, weight, radiator area, reactor outlet-temperature, reactor thermal power, and power conversion system efficiency are presented and used for the design and integration of the system with the Space Base. (auth)

11492 UNMANNED REACTOR-THERMOELECTRIC SYSTEMS FOR APPLICATIONS IN THE 1970's. Van Osdol, J. H.; Howard, J. M. (North American Rockwell Corp., Canoga Park, CA). pp 13.44-8 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The results of a preliminary study of reactor-thermoelectric power systems designed for unmanned space applications are described. These system designs utilize improved thermoelectric converters and a new low-power reactor design. Modifications to the compact lead telluride tubular module have been identified which result in substantial improvements in efficiency. These modifications have been incorporated in the reference module design, and development is under way. The low-power reactor has a design point of 100 kwt at 1200°F for three years. The design incorporates the latest features under development by Atomics International for the Atomic Energy Commission. In addition to typical system performance characteristics, some of the mission-dependent features of reactor-TE systems are presented,

including dormant operation, survivability, and spacecraft thermal power requirements. It is concluded that reactor-thermoelectric systems can meet the power system requirements for unmanned missions in the 1970's and beyond. (auth)

11493 STATUS REPORT ON THE U.S. THERMIONIC REACTOR PROGRAM. Beard, D. S. (Space Nuclear Systems Div., Washington, DC). pp 14.1-4 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The technical results since the September 22-26, 1969 Intersociety Energy Conversion Engineering Conference are presented. One of the significant highlights is the 10,000 hour lifetime achievement on a fission heated thermionic converter. Overall thermionic program aspects including short and long range objectives are presented. (auth)

11494 THERMIONIC REACTOR SYSTEMS FOR ELECTRIC PROPULSION. Mondt, J. F. (Jet Propulsion Lab., Pasadena, CA). pp 14.11-18 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The preliminary design studies of unmanned electric propulsion spacecraft are summarized, with primary emphasis on the in-core thermionic reactor power subsystem. A 70-kWe power subsystem, with an external-fuel thermionic reactor, is shown integrated into a large L/D (~ 20) electric propulsion spacecraft. The 70-kWe spacecraft is designed for launch to Earth escape with a Titan-Centaur. Two 300-kWe reactor designs (external-fuel and flashlight designs from Atomic Energy Commission contracted studies) are integrated into 270-kWe electric propulsion spacecraft. The 270-kWe spacecraft are designed for launch to a 700-nmi Earth orbit with a Titan III-C/7 booster. The 70-kWe thermionic reactor power subsystem is also conceptually shown as a space base power plant. (auth)

11495 100 kWe THERMIONIC POWER SYSTEM DESIGN. Gietzen, A. J.; Homeyer, W. G. (Gulf General Atomic Inc., San Diego, CA). pp 14.19-26 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

An in-core thermionic power system to provide 100 kW net electric power and to meet the shielding requirements of a manned spacecraft is described. The power is produced by thermionic fuel elements similar in design to those now being tested in-pile. Waste heat is removed from the reactor by pumped NaK loops and radiated from heat pipe panels arranged in a cylindrical structure. The electrical output from each pair of fuel elements is processed from ~ 10 volts dc to ~ 200 volts dc for transmission to the spacecraft. Factors to be considered in integrating the power system with the Space Base are also discussed. (auth)

11496 NUCLEAR THERMIONIC POWER PLANTS IN THE 50 TO 300 kWe RANGE. Van Hoomissen, J. E. (General Electric Co., Pleasanton, CA); Sawyer, C. D.; Prickett, W. Z. pp 14.27-31 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The results of recent studies performed by General Electric on in-core thermionic reactor power plants in the 50 to 300 kW(e) range are reviewed. In particular, a 100 kWe manned Space Base mission and a 240 kWe unmanned electric propulsion mission are singled out as representative design points for this concept. (auth)

11497 DESIGN STUDY OF A 350 kWe OUT-OF-CORE NUCLEAR THERMIONIC CONVERTER SYSTEM. Breitwieser, R.; Lantz, E. (Lewis Research Center, Cleveland). pp 14.32-9 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

Nuclear-thermionic systems with the thermionic converters outside the reactor have been re-examined in the perspective of several recent technical advances: new high-temperature, corrosion-resistant, high-strength alloys; high-heat-flux heat pipes; improved thermionic converters; and light-weight, vapor-cooled radiators. These have been combined to yield a new look to the out-of-core approach. A compact reactor results; insulators are eliminated by the use of heat pipes as electrically resistive elements; and weights are reduced by combining vapor-cooled radiators, structural supports, and current leads into vapor-cooled-radiator modules. The overall design is also highly modular and thus provides high reliability and a reduction in development costs. (auth)

11498 INCORE THERMIONIC REACTOR ITR: PROGRAM AND PRESENT DEVELOPMENT STATUS. Gross, F. (Brown, Boveri and Cie AG, Mannheim, Ger.); Pruschek, R. pp 14.45-53 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The goals of the Incore Thermionic Reactor (ITR) program in the Federal Republic of Germany (FRG) are to develop, construct, and qualify a nuclear reactor power source which utilizes incore thermionic diodes for the direct conversion of heat to electricity. The project is funded by the Federal Ministry for Education and Science (BMBW) and the Federal State of Nordrhein-Westfalen and is a joint venture of an industrial consortium consisting of Brown Boveri, INTERATOM and Siemens, and of the Nuclear Research Center (KFA) at Jülich. Several research institutes in Stuttgart and Braunschweig also contribute on advanced and peripheral studies. In the early phase of thermionic reactor work in Germany, different reactor systems were studied. Since 1968 the German development activities have concentrated on a moderated ITR concept (1). In the first phase of this project, it is intended to build and operate a critical assembly and a small experimental reactor with an electrical power output of 20 kW. This latter experiment is intended to be used as a test bed reactor for thermionic fuel elements and is anticipated to provide the experience required for the construction of further reactors of this type. The reactor will be operated by the Nuclear Research Center at Jülich. The ground test reactor, the test facility and the present status of development of thermionic diodes, components and thermionic fuel rods are described. (auth)

11499 PERFORMANCE OF THE THERMOELECTRIC CONVERTER FOR THE ZIRCONIUM HYDRIDE REACTOR THERMOELECTRIC SPACE POWER SUPPLY. Asquith, J. G. (North American Rockwell Corp., Canoga Park, CA); Kenney, J.; Rose, C. M.; Du Val, R. A. pp 15.76-83 of Energy 70, Proceedings. Vol. 2. Hinsdale, Ill.; American Nuclear Society (1970).

From fifth annual intersociety energy conversion engineering conference; Las Vegas, Nev. (21 Sep 1970). See CONF-700912-(Vol.2).

The ZrH reactor thermoelectric system is being evaluated for application in the NASA Space Station utilizing a compact PbTe converter. The converter consists of arrays of individual tubular modules coupled to the reactor and to the heat rejection radiator via NaK loops. Individual tubular modules and converter subassemblies designed for the Space Station application have been fabricated and tested both in electrically heated test systems and in flowing NaK test systems simulating operational temperature and flow profiles. Data from the module and converter subassembly tests are presented along with a summary of the key operational performance parameters. (auth)

11500 REACTOR CORE FOR THERMIONIC NUCLEAR REACTOR. Gross, Franz; Krapf, Rudolf (to Brown, Boveri and Cie AG). U. S. Patent 3,683,209. 8 Aug 1972. Priority date 3 Jan 1967, Germany.

This invention relates to a reactor core particularly for a fast-type reactor, provided with nuclear fuel, for direct conversion into electrical energy of released heat produced by nuclear fission. The heat-to-electricity conversion takes place by means of thermionic converters having an inner-positioned collector and an outer-positioned emitter. The nuclear fuel is subdivided into subcritical discs whose reactivity is influenced by a change in their mutual distance from each other; and the thermionic converter is imbedded in these individual discs. Additional controls in the form of control rods may also be provided to change the reactivity of the reactor core. (Official Gazette)

Research and Test Reactors

Refer also to abstracts 9507, 9768, 11274, and 11374.

11501 (ARH-SA-135) CRITICAL PARAMETER CALCULATIONS WITH HIGH BURN-UP PLUTONIUM SOLUTIONS. Carter,

R. D. (Atlantic Richfield Hanford Co., Richland, Wash.). 7 Nov 1972. Contract AT(45-1)-2130. 15p. (CONF-721109-11). Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

Data from plutonium solution critical experiments were used to provide correction factors for critical parameters calculated using various computer codes and cross section sets. The experiments were performed in a cylindrical water-reflected steel tank using nitrate solutions of plutonium. Correction factors for calculated k_{eff} with solution concentration and isotopic composition are presented. (H.D.R.)

11502 (BLG-471) INTERCOMPARISON OF DIFFERENTIAL NEUTRON SPECTROMETRY TECHNIQUES IN THE MOL-ΣΣ FAST ASSEMBLY. Bluhm, H.; Fieg, G.; Werle, H.; Ames, H.; Braak, J. P.; Harry, R. J. S.; Montizaan, J.; de Leeuw-Gierts, G.; de Leeuw, S. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Jul. 1972. 19p. (KFK-1658; RCN-172). NTIS (U. S. Sales Only).

The determination of neutron spectra by means of differential spectrometry techniques is a powerful tool to check and evaluate nuclear data. But to reach this objective it is of primary importance to define the confidence that may be attributed to the spectral results, with errors and uncertainties related to many parameters, such as cross sections of the reaction used, detection equipment and unfolding codes. Though only an intercomparison on a large scale can give a valuable estimation of the uncertainties, the differential neutron spectrometry techniques of KFK, RCN and C.E.N./S.C.K., i.e., (n,p), ^{3}He(n,p)t and ^{6}Li(n,α)t were intercompared in the MOL ΣΣ fast assembly. With the care and the precautions taken under the experimental conditions described, an agreement of ±5% is generally found between 0.02 and 4 MeV, consequently the same confidence can stand for the neutron spectra measured in similar nuclear and experimental conditions. (auth)

11503 (DOCKET-50231-128) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. First Annual Status Report for the Deactivated Reactor, November 1972. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 21 Nov 1972. 9p. Dep. NTIS.

11504 (DOCKET-50231-129) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Change 15. (Directorate of Licensing (AEC), Washington, D. C.). 8 Dec 1972. 9p. Dep. NTIS.

Revised technical specifications are presented concerning security requirements for the reactor. (D.C.C.)

11505 (EURFNR-1021) DESIGN, IRRADIATION, AND POST-IRRADIATION EXAMINATION OF OXIDE FUEL PINS IN THE FR-2. Freund, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). May 1972. 93p. (KFK-1376). Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The irradiation of fuel pin samples with oxide fuel and stainless steel cladding in the Karlsruhe thermal reactor FR 2 represents the first phase of an extensive irradiation program dealing with the development of fuel elements for fast breeder reactors. During this phase a total of 292 samples has been irradiated in irradiation rigs in core positions as well as in the short term irradiation facility in the FR 2 helium loop. This phase of the program includes irradiation of samples with UO_2 fuel, partially with different admixtures (Mo, CeO_2), and with UO_2–PuO_2 fuel of various enrichments and densities. The cladding materials of these samples consist of the austenitic stainless steels 1.4541, 1.4550, 1.4970, 1.4981, and 1.4988. The fuel pin outer diameters vary in the range of 4.7 to 12.0 mm, with fuel lengths between 80 and 225 mm. The irradiation time of the samples covers the range of from some minutes up to 600 days (full power equivalent). The linear rod power lies between 300 and 1000 W/cm at clad temperatures from 340 to 800°C. Maximum burnup values of about 120 MWd/kg Metal have been achieved. The problems and objects of the different irradiation groups are described. Specifications and production of the samples, irradiation data and some results of post irradiation examination are reported and discussed. (54 references) (auth)

11506 (FMRB-41/72) EXPERIENCE WITH PRODUCTION AND INSTALLATION OF NEUTRON GUIDE TUBES WITH CIRCULAR CROSS SECTIONS. Friedrich, H.; Heintz, W. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Aug 1972. 35p. (In German). Dep. NTIS (U. S. Sales Only).

Neutron guide tubes with circular cross section have the advantage of simple production and installation and resulting low costs. The experience gained with two guide tubes installed at the swimming-pool-reactor of the "Physikalisch-Technische Bundesanstalt" is described. Some examples are given of the space and angle dependent spectral neutron distribution. The core configuration facing the beam tube with the two guide tubes has a considerable influence on the total number of neutrons available. (auth)

11507 (KURRI-TR-93) HIGH NEUTRON-FLUX REACTORS AND THEIR UTILIZATION. Shibata, Shunichi (comp.) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 84p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A compilation of nine papers on the use of high-flux reactors is presented. They include: "Status of high-flux thermal reactors", "Concept of high neutron flux reactors", "Preliminary studies on high-flux thermal reactors at the Kyoto University Reactor", "Reactor physics and reactor engineering studies with KUR-2", "Neutron diffraction with the KUR-2", "Nuclear physics and nuclear chemistry studies with the KUR-2", "Chemical research facilities of the KUR-2", "Special irradiation facilities", and "Problems associated with neutron irradiation facilities for medical and biological use". Two appended articles are also included in the collection; they are: "Future plans for nuclear research by university-connected personnel in Japan," and "Concept of a critical assembly for joint use with universities". (TTT)

11508 (NP-19459) OECD HALDEN REACTOR PROJECT. Twelfth Annual Report, 1971. (Organization for Economic Co-operation and Development, Paris (France). European Nuclear Energy Agency, Paris (France)). 196p. Dep. NTIS (U. S. Sales Only).

Irradiation of a large number of instrumented test fuel assemblies in the Halden reactor continued during the year. The main objective of these irradiations remained the detailed observation of in-core behavior of typical water reactor fuel at high powers and at high burn-ups, emphasizing an increased understanding of various types of mechanisms leading to fuel rod failures. The computer control work continued with emphasis on practical utilization of the concepts of optimal control theory for on-line reactor control. Computer systems development has concentrated on development of an operator-process communication system with graphic and alpha-numeric color displays, and on a high reliability multi-computer system with a fail-safe structure. 58 references. (auth)

11509 (ORNL-TM-4048) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JULY, AUGUST, AND SEPTEMBER OF 1972. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

With only three end-of-cycle shutdowns during the quarter, the reactor on-stream time was 97.0% which increased the operating time percentage for the year to 94.4. A leak, found in an underground portion of the secondary coolant line, was attributed to improper application of the external protective coating in a localized area. An impressed current cathodic protective system was installed to prevent corrosion of any pipe surface on which the protective coating had failed. (auth)

11510 (ORNL-TM-4054) BULK SHIELDING FACILITY QUARTERLY REPORT, JULY, AUGUST, AND SEPTEMBER OF 1972. Tabor, W. H.; Hurt III, S. S.; Lance, E. D. (Oak Ridge National Lab., Tenn.). Dec 1972. Contract W-7405-eng-26. 27p. Dep. NTIS.

The BSR operated at an average power level of 1,983 kW for 63.9% of the time during July, August, and September. Water-quality control in both the reactor primary and secondary cooling systems was satisfactory. There were no unscheduled shutdowns during the quarter. Changes as authorized by Reactor Instrument and Controls Design Change Memoranda Nos. BSR-2Mw-36 and BSR-2Mw-37 were completed. The PCA was not used during this report period and remained in a secured condition. (auth)

11511 IRRADIATION CAPSULE WITH A VARIABLE SPECTRUM FOR NUCLEAR REACTORS. Breant, P.; Javellaud, J. (to Commissariat a l'Energie Atomique). French Patent 2,108,836. 26 May 1972. Filed 9 Oct 1970. (In French).

A capsule for the neutron irradiation of samples in an atomic pile is presented. This capsule possesses an inner and an outer container. The space between these containers can be filled with a given quantity of a product which either absorbs or transmits thermal neutrons. In this way, the ratio of the fast flux Φ_r to the thermal flux Φ_{th} can be controlled. (France)

11512 EXTENDED IRRADIATION BASKET FOR THE PRESSURE TUBE OF THE GAS LOOP OF A REACTOR. Nogues, M. (to Commissariat a l'Energie Atomique). French Patent 2,112,045. 16 Jun 1972. Filed 6 Aug 1970. (In French).

An extended basket for the pressure tube of the gas loop of a reactor is described. This basket enables very high temperatures (>1000°C) to be obtained around the fuel rods while maintaining the gas (preferably He) temperature in the loop within the permissible limits. (France)

11513 EXTENDED GAS LOOP FOR IRRADIATION IN A REACTOR. Dupuy, G.; Recule, A. (to Commissariat a l'-Energie Atomique). French Patent 2,112,046. 16 Jun 1972. Filed 6 Aug 1970. (In French).

An extended-type gas loop for a reactor is described. This loop enables fuel rods to be irradiated in He at very high temperatures without introducing any other source of heat than that due to the irradiated fuel elements. (France)

11514 NUCLEAR PROPERTIES AND FUTURE PLAN OF PULSE REACTOR. FOCUSING ON REPETITIVE FAST PULSE REACTORS. Suita, T.; Sumita, K. (Osaka Univ., Suita, Japan). Genshiryoku Kogyo; 18: No. 2, 9-15(Feb 1972). (In Japanese).

A plan of developing a repetitive fast pulse reactor is proposed. As a first step, construction of a medium-scale repetitive fast pulse reactor JLBF (Japan Linac Booster Facility) was recommended in 1971. The JLBF consists of a 200 MeV linear accelerator, and a 13 liter sodium cooled core with 120 kg of 93% enriched uranium, and a Be reflector rotating at 3,000 rpm. Planned performance of the JLBF includes: (1) effective neutron flux $\geq 1 \times 10^{15}$ n/cm^2.sec. (2) fast neutron pulse width ≤ 10 μs. (3) reactor average power 500 kW. (4) reactivity amplitude $-5\$ \sim$ below $1\$$. (5) fuel maximum temperature 450°C. Research and developmental problems are as follows: development of three dimensional transport code; technical problems associated with construction of the high speed rotating reflector; and experiment and analysis of thermal fatigue caused by irradiation by pulsed neutrons. Finally, organizational problems remain to be solved for realization of this plan. (Japan)

11515 CRITICAL EXPERIMENT EOLE. Del Negro, R. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 168, 71-8(Mar 1972). (In French).

Eole is a critical assembly originally intended for studying neutronics in conjunction with heavy water lattices. It has recently been used to study the behavior of thermionic fuel elements in a light water lattice. The geometry of the core used for these studies is indicated. Various aspects of the program developed are described. (France)

11516 CRITICAL ASSEMBLIES CESAR AND MARIUS. Morier, F.; Guerange, J.; Langlet, G.; Bosser, R. (CEN de Cadarache, Saint-Paul-les-Durance, France). Bull. Inform. Sci. Tech. (Paris); No. 168, 29-44(Mar 1972). (In French).

The critical assemblies Marius and Cesar were constructed for the study of the neutronics of graphite moderated natural uranium lattices. Marius, which was constructed at Marcoule in 1960 was transferred to Cadarache in 1965. In 1970, it was transformed into an assembly for studying high temperature lattice measurements. Cesar was also installed at Cadarache; this critical assembly, which can be used up to a temperature of 450°C, went critical in December 1964; it was adapted to experiments for the study of high temperature reactors in 1971. The current program involves a pebble loaded core and is being undertaken in the framework of a contract between the CEA and KFA Julich. Cesar and Marius were constructed and are operated in accordance with a joint Electricite de France/CEA program. (France)

11517 ZIRCONIUM CALANDRIA FABRICATION FOR TAIWAN REACTOR. Narduzzi, E. D.; Reynolds, D. E. H. (Dominion Bridge Co. Ltd., Montreal). Metal Constr. Brit. Weld. J.; 4: No. 12, 448-52(Dec 1972).

The vertical cylindrical calandria for the Taiwan Research Reactor is described and reasons for the choice of Zircaloy-2 as the material are given. All fabrication had to be integrated into a critical path network. This involved detailed planning procedures which resulted in the calandria being completed ahead of schedule. The procedures described include extensive welding development, programs for the training of personnel, clean room facilities, trial fabrication of tube sheet, and final welding and assembly. (UK)

11518 SUBCRITICALITY MEASUREMENTS ON SR-OF REACTOR USING PULSED NEUTRON SOURCE. Petenyi, Vincent; Rohar, Stefan; Kacmary, Stefan. Jad. Energ.; 18: No. 11, 362-6(Nov 1972). (In Slovak).

Measurements on the ŠR-OF reactor with a pulsed neutron source are described. The comparison of different methods of subcriticality evaluation and experimental instrumentation testing were main aims of the measurements. (auth)

11519 OSCILLATION OF FISSILE MATERIALS IN THERMAL-NEUTRON CRITICAL ASSEMBLIES: THE EQUIVALENT SAMPLE METHOD. Laponche, B.; Brunet, M.; Bouedo, Y. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Sci. Eng.; 48: No. 3, 305-18(Jul 1972).

A method is described for the analysis of oscillation measurements in critical assemblies where fissions are produced predominantly by thermal neutrons. The oscillation method developed in the CEA deals with the measurement of two signal: the "global" signal, which gives a representation of the sample reactivity, and the "local" signal, which gives the variation of the neutron density at the vicinity of the sample. Using a double calibration of the reactor by samples of enriched or depleted uranium and boronated uranium, it is possible to obtain independently the absorption and production reaction rates for plutonium in each sample, as a function of ^{235}U reaction rates. The equivalent sample method is a more recent development and is based on the fact that a given perturbation of the absorption cross section, with any law of variation with energy in the thermal region, can be replaced by an absorption of well-known variation with energy which has the same effect on the neutronic density in the reactor beyond a small distance where spectrum effects are still appreciable. A series of measurements of uranium/plutonium rods performed in the CESAR reactor, from 20 to 400°C, is analyzed, and modifications of the absorption and fission cross sections of plutonium isotopes are proposed. (auth)

11520 EXPANDED EXPERIMENTAL POSSIBILITIES OF METHODS BASED ON STUDY OF THE NEUTRON NOISE OF A NUCLEAR REACTOR. Bulavin, V. V. This paper was summarized in At. Energ. (USSR); 31: No. 2, 133(Aug 1971) as paper No. 509/6024. (In Russian).

Full copy of this paper is held by TIC.

A method is proposed for analyzing the neutron noise in zero power reactors based on the assumption of a one-rate point kinetic model. (auth)

Production Reactors

11521 METHOD OF DETECTING THE PRESENCE OF A DEFECTIVE LITHIUM–ALUMINATE TARGET IN A REACTOR. Cooperstein, Raymond. U. S. Patent 3,698,996. 17 Oct 1972. Filed 24 Nov 1970.

A rare earth isotope which emits γ rays upon neutron irradiation is added in amounts from 0.1 to 2.0 wt % to the target elements. This enables defective elements to be detected in liquid-cooled reactors by monitoring the effluent for γ rays. The addition may be an oxide of ^{140}Ce, ^{142}Ce, ^{141}Pr, ^{152}Sm, ^{158}Gd, ^{164}Dy, or ^{175}Lu. (D.L.C.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 9520, 9768, 9930–9932, 9935, 9962, 9963, and 10036.

11522 (KFK–1619) INVESTIGATION WITH SIMULATED FISSION PRODUCTS AND UO_2 ON COMPATIBILITY RELATION OF FUEL RODS. Goetzmann, O.; Hofmann, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jul 1972. 173p. (In German). Dep. NTIS (U. S. Sales Only).

The initial system of a fuel pin consisting of an oxide fuel and a stainless steel cladding is thermodynamically stable. Nevertheless, heavy cladding attack is sometimes found in such fuel pins. The reactions with the cladding materials become possible by the chemical changes the fuel undergoes during burnup in the reactor. A research program on the reaction possibilities of fission products with cladding materials is described. Various cladding materials were annealed out-of-pile in contact with simulated fission products and mixtures thereof in presence and absence of UO_2. The results of these annealing tests are represented by many micrographs and microprobe pictures. As in other investigations it was also found that reactions between Cs and the cladding materials are only possible in the presence of oxygen or at a certain oxygen potential in the system. Te and Se are also aggressive fission products. Their reactions with the clad do not depend on the oxygen potential in the same way as those with Cs do. I and Br in the unbonded state cause severe

attack on the cladding materials. Bound to Cs as CsI or CsBr, respectively, they are not dangerous. With surplus oxygen in the system, however, reactions with CsI or CsBr and the cladding materials take place due to further bonding of the Cs. Other fission products like Sb, Cd, In and Sn may react with the cladding materials. 13 references. (auth)

11523 (RDT-M-14-2-T) FUEL AND CONTROL ASSEMBLY TAG GAS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1972. 17p. RSO.

A standard is presented which describes the requirements for tag gas to be used for locating failed driver fuel pins and control rod absorber pins in the reactor by the failure monitor system. The tag gas consists of varying isotopic mixtures of xenon, krypton, neon, or other gases. (auth)

11524 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL BODIES. Horsley, G. W. (to United Kingdom Atomic Energy Authority). British Patent 1,279,608. 28 Jun 1972. Filed 16 Oct 1968.

Reference is made to coated-particle ceramic fuels. The fuel described comprises particles of fissile material having a coating that includes a C-containing layer adjacent to the particle. The fuel is in the form of a compound of a fissile element with one or more nonfissile elements, such as oxygen, that can be released to produce a gaseous product on irradiation, and contains a "gettering" substance capable of combining with the gaseous product. The "gettering" substance should not react with the fuel material and should have a low neutron capture cross section, and for association with an oxide fuel SiC is particularly suitable, in proportions 0.07 to 0.735% by weight. (UK)

11525 NUCLEAR REACTORS. Capewell, R. S. (to United Kingdom Atomic Energy Authority). British Patent 1,286,672. 23 Aug 1972. Filed 17 Mar 1969.

With some types of reactors, for example, those with top refuelling of vertical fuel element channels, refuelling operations can be difficult due to coolant flow-induced oscillation or vibration of fuel element assemblies as they are inserted in or withdrawn from fuel element channels. At such times fuel element assemblies are unsupported, except for the lowering or lifting means, and the problem can be aggravated in that, as the fuel element assemblies are withdrawn, the coolant flow tends to increase due to the reducing coolant flow resistance in the emptying channel. In the arrangement described, a coolant flow-restricting means is provided comprising a fluid diode with a movable shroud to change the flow-restricting effect. With vertical fuel element channels the shroud may be attached to the lower end of fuel element assemblies. The fluid diode may comprise surfaces defining the coolant flow entry to the channel and profiled so as to induce reverse flow eddy currents in the coolant flow, thereby retarding flow through the channel. The foregoing surfaces may comprise a number of vertical cascades of deflector vanes inclined to the longitudinal axis of the channel, with the angles of inclination progressively increasing in the direction of coolant flow. (UK)

11526 CONTROL SYSTEM FOR NUCLEAR REACTORS. Dupuy, G. (to Commissariat a l'Energie Atomique). French Patent 2,108,960. 26 May 1972. Filed 23 Oct 1970. (In French).

A static device for controlling a nuclear reactor is presented. This device is intended to replace the classical control rods. It consists of at least one sealed metallic tube which crosses the core of the reactor, this tube being cooled on its outer surface by a circulating coolant. This tube is closed at one end and is joined at its other end to a reservoir containing a neutron absorbing fluid. The tube contains a liquid control fluid which is vaporized at a predetermined rate by an adjustable heat source which surrounds the tube outside of the core at opposite end to the reservoir. The internal surface of the tube is coated with a porous material. This internal surface is wetted by the control fluid which condenses on the inside wall of the tube cooled by the coolant, and vaporizes from the wall of the tube heated by the source; this process depends upon the volume of absorbing fluid present in the tube. (France)

11527 MANIPULATION GRAPNEL. Ventre, E. (to Electricite de France). French Patent 2,104,696. 21 Apr 1972. Filed 31 Jul 1970. (In French).

The deterioration due to nuclear radiations and high temperatures in the control parts of a grapnel used to recharge nuclear reactors with fuel elements can be avoided using a new type of grapnel. In this new type of grapnel, the simultaneous displacement of the gripping claws with respect to one another between the gripping and releasing positions is produced by a thermal effect (differential expansion) acting on the metallic parts actuating these claws. (France)

11528 NUCLEAR FUEL ASSEMBLY. Agranier, J. C.; Chalony, A. (to Commissariat a l'Energie Atomique). Canadian Patent 902,277. 6 Jun 1972. Priority date 17 Sep 1969, France.

A fastening system is described for retaining fuel pins longitudinally in a fluid coolant guide jacket in a fuel assembly consisting of a regularly arranged bundle of fuel pins. At least two parallel rods are attached transversely to a tube unitary with the jacket and contained therein. Parallel rails slide on the rods and extend beyond the terminal edge of the tube. Guide members are each associated with a rail and slide thereon and in the plugs of the fuel pins, forming a single layer to retain the pins on the rail. The guide members are immobilized by the jacket when it is in place. (Canada)

11529 MANIPULATING HEAD FOR PARTS OF A NUCLEAR REACTOR. Brandstetter, R. (to Commissariat a l'Energie Atomique). French Patent 2,112,033. 16 Jun 1972. Filed 24 Jul 1970. (In French).

A system for manipulating the fuel element assemblies or control rods of nuclear reactors with a high degree of safety is described. These parts are provided with a head allowing them to be transferred directly from one device to another, thus reducing the number of manipulations. (France)

11530 PROCEDURE FOR THE PRODUCTION OF CORES OF POROUS PARTICLES WITH PRE-SET POROSITY. Lefevre, R. L. R. (to Commission of European Communities). German Patent 2,143,337. 13 Apr 1972.

The procedure described is as follows: The nucleus is coated with a material which gives porosity to the nuclear fuel powder coatings. This can be done by removing the core material (for instance stearic acid), as for example by heating, which will leave the particle undamaged. This is followed by particle sintering. The several layers of the nuclear fuel powder may also be put around a nucleus consisting of porous inert material. (GF)

11531 SAFETY LIQUID ROD DEVICE WITH A MEMBRANE ACCUMULATOR. Agazzi, A.; Broggi, A.; Galli de Paratesi, S.; Ghiurgi, L. (to European Atomic Energy Community). Canadian Patent 900,060. 9 May 1972. Priority date 26 Oct 1967, Belgium. (In French).

A new safety liquid rod device for a nuclear reactor injects poison solution rapidly into the rods by means of one or more membrane accumulators. The circuit of poison solution consists of a reservoir and a pump. A membrane divides the accumulator for the poison solution into a lower chamber containing the solution and an upper chamber containing gas under pressure. An overflow accumulator is included in the design. (Canada)

11532 NUCLEAR REFUELLING ARRANGEMENT. McConkey, Kenneth Norman (to Canadian General Electric Co. Ltd.). British Patent 1,277,383. 14 Jun 1972. Filed 16 Mar 1971.

Reference is made to a system for the on-load refuelling of a liquid cooled nuclear reactor. The fuel channels are provided with a number of latch fingers extending radially inwards when in a closed position to engage end surfaces of a fuel bundle in the channel and prevent axial outward movement of the bundle. Axial clearance is provided between adjacent bundles to receive the fingers when loading a bundle. On initial insertion of a bundle into a channel the axial loading exerted on the fingers by a bundle already within the channel may be relieved by axial loading contact between the adjacent bundle end portions. A suitable fuel bundle is described, together with the method of insertion into fuel channels. (UK)

11533 DEVICE FOR ATTACHING NUCLEAR FUEL PINS IN AN ASSEMBLY. Agranier, J. C.; Cayol, A. (to Commissariat a l'Energie Atomique). Canadian Patent 902,276. 6 Jun 1972. Priority date 19 Sep 1969, France.

A device for connecting fuel rods to a support in a fuel assembly is described. The assembly consists of a fluid coolant guide shroud, a bundle of parallel elongated fuel pins in a regular arrangement, and means for retaining the bundle. This means consists of at least two parallel spindles attached to a support on the jacket and disposed transversely of the direction of coolant circulation; parallel rails are perpendicular to the spindles and slidable on it and in end plugs of all pins belonging to a layer to retain the pins, with the shroud preventing the pins of the bundle from sliding off the rails and the rails from sliding off the spindles. The advantage of the device is the elimination of the need for threading the fuel pins individually onto the grid. (Canada)

11534 NEUTRON SPECTRA FROM 0.05 TO 10 MeV IN CERTAIN SHIELDING MATERIALS. Veselkin, A. P.; Voskresenskii, E. V.; Egorov, Yu. A.; Pankrat'ev, Yu. V.; Piskunov, V. I. This paper was summarized in At. Energ. (USSR); 30: No. 4, 386(Apr 1971) as paper No. 481/6001. (In Russian).

Full copy of this paper is held by TIC.

A fast neutron single-crystal scintillation spectrometer and a ^{3}He spectrometer were used to measure neutron spectra in hydrogeneous materials—lithium hydride and a polyethylene—lead mixture; in materials composed of elements of intermediate atomic weights—graphite, borated graphite, and serpentine concrete; in heavy materials in which the moderation of fast neutrons is mainly by inelastic scattering—titanium, steel, and lead. The experiment was performed at a water-cooled water-moderated research reactor. The measurements with the ^{3}He spectrometer were made under conditions close to semiinfinite geometry and those with the scintillation spectrometer under conditions of shield geometry. The experimental results were normalized in the 0.8—1.4 MeV energy region. The experimental error does not exceed 20—30% The neutron energy distributions are used to compute the attenuation functions and the relaxation lengths of the neutron fluxes in nine energy groups. The error in determining the relaxation lengths is 5—8%. 13 references. (auth)

11535 DEVICE FOR RECORDING THE CHANGES IN A PHYSICAL PARAMETER (PRINCIPALLY TEMPERATURE). Aldonce, Roger; Le Guernigou, J. M.; Dupay, Francis; Vautrelle, Henri (to Commissariat a l'Energie Atomique). French Patent 2,071,037. 23 Aug 1971. Filed 16 Dec 1969. (In French).

A recording device for controlling the changes in a physical parameter (principally temperature), which is suitable for monitoring the rise in temperature of the cladding of nuclear reactor fuel elements, is presented. A recording system measures the difference between the measured temperature and a certain threshold temperature during a given lapse of time. Throughout this temperature interval, the device controls the rise in temperature in such a way as to trigger an alarm only when certain safety conditions have been violated. (France)

Reactor Physics and Core Engineering

Physics

11536 (CONF-721109-5) MONTE CARLO REACTIVITY CALCULATIONS USING A PERTURBATION SOURCE. Hoffman, T. J.; Petrie, L. M. (Oak Ridge National Lab., Tenn.). [nd]. 5p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

11537 (ORNL-TM-3958) INCORPORATION OF OUTER ITERATION TECHNIQUES INTO THE TASK ALGORITHM. Lillie, R. A. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 76p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

In order to reduce calculation time and storage requirements of a recently developed transfer-scattering algorithm, an outer iteration scheme was developed and incorporated into the existing algorithm. The coupled algorithm is capable of handling the discrete ordinate transport model in the frequency domain. A supergroup energy structure (i.e., placement of groups into sets of groups) was utilized in the development of the outer iteration scheme. To accelerate convergence in distributed source calculations, a method of iteration based on the theory of subcritical source multiplication was also utilized. Results from a series of eigenvalue calculations using the coupled algorithm were compared with results generated using a standard source iteration method. In addition, the coupled algorithm was used to calculate the spatially dependent source transfer function for a slab mockup of an experimental fast reactor. Results from this calculation were compared with results obtained using the unmodified transfer-scattering algorithm. Excellent agreement was achieved in both comparisons. In order to demonstrate the reduction in problem size restriction, calculations were performed using a large energy-angular structure which could not be handled by the unmodified transfer-scattering algorithm. The calculated detector response resulting from these calculations was compared with the detector response obtained from a wave propagation experiment. Excellent agreement was achieved. (26 references) (auth)

11538 NPY-COOPERATION IN REACTOR PHYSICS. Zelazny, Roman (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 16: No. 9-10, 447-70(1971).

The main organizational concepts of the Cooperation in Reactor Physics among Norway, Poland, Yugoslavia and IAEA, called shortly NPY-Project, established in 1964 are described. Then the scientific objectives, which were the goals of this 7 years cooperation, are discussed in a more detailed way. On the basis of the output of this cooperation the highlights of the scientific, technical and organizational achievements are presented. Among them the merits of three International Advanced Summer Schools and many Seminars organized in the framework of this cooperation are discussed. Physical problems of particular interest for three cooperating parties and for the rest of the scientific community of IAEA state members, which were attacked and solved within the framework of NPY-Project, are formulated and elucidated. At the end there is an attempt to formulate conclusions for cooperating parties and the IAEA, and for possible activities which could emerge out of this Project. The catalyzing and supporting assistance of the IAEA during the creation and existence of the Project is highly appreciated and acknowledged. (auth)

11539 - FLUX SHAPE MODE TRANSFER FUNCTION FOR A NUCLEAR REACTOR. Imasaki, Masahide; Nogami, Gyoichi (Kyushu Inst. of Tech., Japan). Nippon Genshiryoku Gakkaishi; 14: No. 8, 406-14(Aug 1972). (In Japanese).

With particular reference to the fundamental mode of Xe oscillation, the characteristic roots of the rational function (two-dimensional analysis) and the transcendental function (one-dimensional analysis) are compared by changing the reactivity coefficient of the moderator. The root-loci of the two analytical methods agree well with each other. Concerning this root-loci, one should note that there are two roots which change very much, and that the stability of the mode is essentially determined by these roots. The cause of the difference on the functional form lies in the thermal system. To confirm the above results, the frequency responses of the thermal system, therefore, were compared between the two methods. Very good agreement was again obtained. To verify the validity of this modal analysis, the characteristic roots are compared with the time response of the first azimuthal mode obtained at Berkeley power station. The calculated roots roughly agree with the experimental value. Miida et al. have reported on a case where the frequency responses of the rational function and the transcendental function differ from each other in the high frequency region. An examination of this case revealed that the most important factor is whether or not the angular velocity approaches the essential singular point. 13 references. (auth)

11540 NOTE ON THE STABILITY OF COUPLED NUCLEAR REACTORS. Goryachenko, V. D. This paper was summarized in At. Energ. (USSR); 30: No. 4, 381-2(Apr 1971) as paper No. 474/5866. (In Russian).

Full copy of this paper is held by TIC.

The stability conditions are derived for the stationary mode of operation of a reactor consisting of two different coupled cores. (auth)

11541 NODAL EQUATIONS DERIVED FROM INVARIANT IMBEDDING THEORY. Weiss, Zbigniew (ASEA-ATOM, Vaesteras, Sweden). Nucl. Sci. Eng.; 48: No. 3, 235-47(Jul 1972).

In one-dimensional systems which consist of N nodes, the two N response matrix equations for the partial currents through the node interfaces have been transformed into a set of N three-point equations with the total in-current per node as the new variable. The resulting coefficients which describe the coupling between neighboring nodes are expressed in terms of the reflection and transmission matrices of the invariant imbedding theory. These coupling coefficients can be compared with those of other nodal equations. In the case of slab geometry this has been illustrated by a direct comparison with the familiar finite difference formulation with the average flux per node as the dependent variable. Also the relation between the method presented and the so-called rigorous finite difference equations has been established. The advantage of this method lies in the fact that the flexibility of the response matrix methods—which describe the nodes in terms of invariant imbedding concepts—has been condensed into the conventional three-point finite difference scheme, for which many well-established solution methods exist. (auth)

11542 TEMPERATURE-DEPENDENT INTERMEDIATE NEUTRON RESONANCE INTEGRALS. Goldstein, Rubin (Combustion Engineering, Inc., Windsor, Conn.). Nucl. Sci. Eng.; 48: No. 3, 248-54(Jul 1972).

The Intermediate Resonance (IR) formulation of resonance absorption is extended to the temperature-dependent case by obtaining an explicit expression for the IR parameters as a function of temperature. Use is made of the tabulated J functions. The resonance integral is given in terms of a temperature-dependent J function as a function of a temperature-dependent IR parameter

and represents the complete generalization of the IR formulation to the temperature-dependent case. The temperature-dependent solutions obtained are similar in analytic form to the zero-temperature solutions and they reduce to the latter in the limit of zero temperature. They also yield the correct narrow or wide resonance limits for all temperatures. The formulation using temperature-dependent IR parameters not only gives accurate temperature-dependent resonance integrals, but also gives reasonably accurate Doppler coefficients. (auth)

11543 CRITICAL TIME STEP APPROACH TO MONTE CARLO RELIABILITY CALCULATION. Geisler, G. C.; Zindler, R. E. (Pennsylvania State Univ., University Park). Nucl. Sci. Eng.; 48: No. 3, 255-65(Jul 1972).

An improved method, called Simulation of System Operation for Reliability Analysis, for utilizing Monte Carlo techniques in the computer analysis of the reliability of complex systems is presented. This method is particularly applicable to systems which employ highly reliable elements with extremely low failure rates. Earlier techniques of Brunot simulate operation of a system through a sequential series of time steps and test for system failure in each time step. After a sufficient number of time steps, a system failure probability can be determined. When such methods are applied to systems composed of highly reliable components, computer time requirements can become excessive. This is due to the great number of time steps which must be examined to obtain statistically significant numbers of system failures. The method described begins by randomly selecting a "critical" time step of failure for each component. Failures are then examined to determine if a system failure combination has occurred in any time step. To continue the simulation, a second critical time step is chosen for each component and added to the first. The program proceeds in this fashion, considering only time steps in which at least one failure has occurred. Thus computer time requirements become essentially independent of failure rates. (auth)

11544 MARSHAK CONDITIONS APPLICABLE IN SPHERICAL GEOMETRY TO THE SIMPLIFIED SPHERICAL HARMONICS EQUATIONS. Staub, Alan; Gelbard, E. M. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 48: No. 3, 359-61(Jul 1972).

The application of the simplified spherical harmonics (SSH) method for neutron transport calculations of critical homogeneous spheres of aqueous solutions of uranium has been reexamined to estimate the error introduced by the use of the simplified P_7 approximation. Recalculation of the critical spheres in the SSH-P_7 approximation with modified Marshak boundary conditions showed that no substantial error was introduced in the earlier analysis. (auth)

11545 TIME-DEPENDENT PHENOMENA IN NEUTRON SLOWING DOWN THEORY. Conn, Robert; Sawan, Mohamed (Univ. of Wisconsin, Madison). Nucl. Sci. Eng.; 48: No. 3, 361-6(Jul 1972).

The analysis of the slowing down of a neutron pulse leads to a detailed analogy between the decay of a pulse in the fast regime versus the decay in the thermal energy region. It is found that the slope, α, of log N(t) versus log(t) depends on the system buckling, B^2. An "α versus B^2" curve exists that is analogous to the "λ versus B^2" curve for thermal systems. Other analogies between fast and thermal time decay are discussed. These analogies exist despite the fact that no time eigenvalue exists for this slowing down problem. (auth)

11546 DEPENDENCE OF THE BREEDING COEFFICIENT IN AN INFINITE HOMOGENEOUS MEDIUM ON THE APPROXIMATION USED FOR THE NEUTRON SCATTERING FUNCTION AT HYDROGEN NUCLEI. Chevnitsa, A. I.; Nikolaishvili, Sh. Sh. This paper was summarized in At. Energ. (USSR); 30: No. 3, 296-7(Mar 1971) as paper No. 466/5622. (In Russian).

Full copy of this paper is held by TIC.

In carrying out calculations associated with nuclear reactors, it is customary to start from the assumption that the elastic scattering of the neutrons at the nuclei in the medium is isotropic with respect to the center-of-mass system. For all nuclei except hydrogen this assumption is practically equivalent to the assumption that scattering is isotropic in the laboratory system of coordinates. Deviations from isotropy may generally be taken into account as transport corrections. As regards scattering at hydrogen nuclei, however, this is exceedingly anisotropic in the laboratory system, and more accurate models are required in order to describe it. Among these, the one used most widely in the Soviet Union is the linear model proposed by G. I. Marchuk. This corresponds to approximating the neutron-scattering function at hydrogen nuclei by the first two terms of its expansion in a series of Legendre polynomials with respect to the cosine of the scattering angle. Comparison of a large number of calculations with experimental data shows that this approximation is entirely satisfactory for the majority of practical purposes. It is nevertheless interesting to know the extent of the error in determining various characteristics of the neutron field in the reactor due to the rejection of the remaining terms in the expansion. In the present investigation this question is studied for one particular example, namely, the calculation of the neutron-breeding coefficient in a homogeneous reactor without any reflector, assuming that the spatial and angular variable are separable. On this assumption, the problem reduces to a one-dimensional transport equation in an infinite, homogeneous space, which may easily be solved by a method analogous to that of Bethe, Tonks, and Hurwitz. Successive approximations of the method correspond to one, two, three, and so on terms in the expansion of the neutron-scattering function at hydrogen nuclei in Legendre polynomials, and depend only on a single parameter κ defining the leakage of neutrons from the reactor. As a result of this, the problem constitutes a very convenient model for estimating the error of current interest. The results are illustrated by calculating the neutron breeding coefficient in uranium–water systems for various values of κ. (auth)

11547 EFFECT OF EMPTY CYLINDRICAL CHANNELS ON NEUTRON MIGRATION. Grigor'ev, I. S. This paper was summarized in At. Energ. (USSR); 30: No. 1, 46-7(Jan 1971) as paper No. 457/5708. (In Russian).

Full copy of this paper is held by TIC.

Measurements of the elongation factors of the squares of the diffusion length $\mathscr{D}_i = L_i^2/L_0^2$ and migration length $\mathscr{M}_i = M_i^2/M_0^2$ in water are reported for different lattices of empty cylindrical reactor channels. All the experimental $\mathscr{D}_{||}$ values for guide channels parallel to the axis were found to be below those computed on the basis of Behrens's formula. These discrepancies are practically entirely eliminated when corrections for the anisotropy in neutron scattering, and specific to the heterogeneous medium, are taken into consideration. (auth)

11548 SYNTHETIC ITERATION METHOD OF PHYSICALLY CALCULATING A MULTIREGION (MULTIPLE-ZONE) REACTOR. Khromov, V. V.; Slesarev, I. S. This paper was summarized in At. Energ. (USSR); 30: No. 3, 296(Mar 1971) as paper No. 465/5710. (In Russian).

Full copy of this paper is held by TIC.

A synthetic iteration method is proposed for calculating the neutron distribution and breeding coefficient k_{eff} of two- and three-dimensional reactors in the multigroup diffusion approximation. This method may be regarded as one of a number of indirect variational procedures. The derivation is based on the application of a variational formulation to the original problem, and hence on the use of the extremal properties of a specially-constructed functional. (auth)

11549 STABILITY OF THE DIRECTIONAL DISTRIBUTION OF NEUTRONS IN REACTORS WITH A DISCRETE CONTROL SYSTEM. Postnikov, I. S.; Sabaev, E. F. This paper was summarized in At. Energ. (USSR); 30: No. 5, 445(May 1971) as paper No. 486/5962. (In Russian).

Full copy of this paper is held by TIC.

11550 STATISTICAL OPTIMIZATION OF NUCLEAR REACTOR SYSTEM BY MEANS OF MODAL ANALYSIS METHOD. Hara, Fumio (Science Univ. of Tokyo). Bull. JSME (Jap. Soc. Mech. Eng.); 15: No. 80, 215-24(Feb 1972).

The optimization of a nuclear reactor system is analyzed with consideration of neutron flux uncertainty. Using the average and two kinds of variance of neutron flux which are obtained by means of modal analysis technique, the maximization of average power output is calculated under the condition to make the uncertainty of neutron flux as small as possible. Numerical results show that the optimal distribution of average neutron flux is not always flat when we consider the uncertainty of neutron flux as a loss of safety or reliability of a nuclear reactor. (auth)

11551 TRANSPORT THEORETICAL CALCULATION OF STATIONARY NEUTRON FIELDS FOR PROBLEMS WITH AXIAL SYMMETRY. Biederbeck, Helge (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie; 20: No. 1, 19-28 (Sep 1972). (In German).

A solution of the stationary neutron transport equation with cylindrical symmetry and isotropic point source is developed, comprising the energy-, space- and angle-dependency of the radiation field. In nonmultiplying infinite media with anisotropic scattering, a two-dimensional Fourier transformation is performed, resulting in a set of Fredholm integral equations. The solution of this set and the inverse Fourier transformation are carried out by means of appropriate numerical methods. (11 references) (auth)

Core Thermal Hydraulics

11552 VISUAL DISPLAY OF LAMINAR AND TURBULENT FLOW. Malherbe, J. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 167, 41-6(Feb 1972). (In French).

The Mechanical and Thermal Studies Service has developed a visual display cell in order to study flow around complex structures. This installation enables different laminar and turbulent flow configurations to be studied, such as those encountered in the channels of nuclear reactors, and singularities of circuits or particular devices. This installation provides a means of observing phenomena which are not normally accessible. In addition to the qualitative results supplied, quantitative analysis can also be effected. (France)

GENERAL

Miscellaneous

11553 (AREAEE-143) GENERATION OF SHOCK WAVES IN WATER. El-Khalafawy, T. A.; Masoud, M. M.; El-Gwaily, M. S.; Zemoskov, A. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1972. 11p. Dep. NTIS (U. S. Sales Only).

11554 (AREAEE-145) DIAMAGNETIC MEASUREMENTS ON THE SHOCK TUBE. El-Khalafawy, T. A.; Masoud, M. M.; Zemskov, A. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1972. 20p. Dep. NTIS (U. S. Sales Only).

11555 (AREAEE-149) CONSTRUCTION AND OPERATION OF CONICAL ELECTRODE DISCHARGE SYSTEM FOR SHOCK WAVE GENERATION. Mahmoud, H. M.; El-Khalafawy, T. A.; El-Gwaily, M. S.; Masoud, M. M. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1972. 30p. Dep. NTIS (U. S. Sales Only).

11556 (AREAEE-150) EXPERIMENTAL METHOD OF MEASURING ENGINE WEAR UNDER A.R.E. CLIMATIC CONDITIONS. Rafat, N. M.; El-Fouly, M. F.; Farag, S. A.; Erian, Z. F. (Atomic Energy Establishment, Cairo (Egypt). Reactors Dept.). 1972. 33p. Dep. NTIS (U. S. Sales Only).

11557 (BDX-613-496) PHOTOFABRICATION PROCESSES FOR PRINTED CIRCUITS. Final Report. Hedrick, R. B. (Bendix Corp., Kansas City, Mo.). Oct 1972. Contract AT(29-1)-613. 52p. Dep. NTIS.

11558 (BDX-613-692(Rev.)) DRY MIXING OF MOLDED DESICCANT. Nicholson, W. J. (Bendix Corp., Kansas City, Mo.). Dec 1972. Contract AT(29-1)-613. 123p. Dep. NTIS.

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